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Intestinal Coccidiosis in Chickens Caused by *Eimeria necatrix*

BY

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Introduction

IN recent years, advances in the control of coccidiosis in poultry have been concerned mainly with the caecal form caused by *Eimeria tenella*. Considerably less attention has been paid to those species of coccidia which parasitise the intestines of chickens. With the increase in intestinal coccidiosis which appears to be associated with present-day intensive husbandry of table poultry, it has become evident that a greater knowledge of the intestinal species is essential. For such an investigation it is necessary initially to determine how the parasite can best be handled in the laboratory. With the development of techniques similar to those which have been used successfully for the study of *E. tenella*, it is then possible to assess the importance of a species as a disease-producing organism, to come to an understanding of the various factors which in the field are likely to control the incidence and severity of disease, and to estimate how far measures of control basically devised for use against *E. tenella* are capable of wider application.

The present study is concerned with *E. necatrix* which in a preliminary investigation appeared more pathogenic than *E. acervulina*. *E. acervulina* can be considered the third most important of the species (*E. tenella*, *E. necatrix*, *E. acervulina*) which produce disease in chickens in Britain.

Since the comprehensive description of *E. necatrix* by Tyzzer *et al.* (1932) few critical examinations of the parasite have been made. Studies at Weybridge have essentially confirmed, and in some directions have extended, Tyzzer's findings.

Laboratory Isolation of *E. necatrix*

A strain of *E. necatrix* was isolated from sawdust litter collected from a poultry deep-litter unit in Hampshire. A suspension of sporulated oocysts prepared from this litter was inoculated orally into coccidia-free chicks which were killed for *post-mortem* examination on the fifth day after infection. A multiple infection of caecal and intestinal coccidiosis was revealed. Some of the lesions in the intestine were thought to be due to *E. necatrix*. The species of Eimeria were subsequently separated by inoculating coccidia-free chicks *per rectum* with a suspension of second generation merozoites obtained from the intestinal lesions, a modification of a technique described by Brackett & Bliznick (1952a). From the region of the yolk stalk, portions of the small intestine which showed colonies of second generation schizonts as minute white areas visible from the serous surface, were opened lengthwise, washed free of intestinal debris in warm physiological saline and trimmed with scissors until only a small area of intestine remained surrounding the white colony. They were then placed in 30 ml. physiological saline at 36° to 40° C. and lightly ground in a Griffith tube. The resulting suspension was checked under the microscope for the presence of free merozoites which appeared as small banana-shaped bodies, pointed at one end, showing sluggish curling and uncurling movements and with average dimensions of 12.1μ by 2.4μ. Each of six two-week-old chicks received 4 ml. of this suspension *per rectum*, volumes of 1 ml. being inoculated at intervals of 15 minutes. A small number of oocysts appeared in the caecal droppings of these chicks two days later. The chicks were then killed, their caeca were removed, and a suspension of oocysts was prepared. After sporulation a further oral infection and merozoite passage was carried out before the numbers of parasites were increased by allowing the life cycle to proceed normally from the time of infection with sporulated oocysts to the eighth day after infection. Numerous oocysts were then collected from the caeca. After sporulation, these produced lesions typical of *E. necatrix* when inoculated into susceptible chicks.

This strain of *E. necatrix* has since been maintained free of other species of coccidia but as a precaution against adventitious infection further merozoite passages have been carried out from time to time.

E. necatrix was isolated also from suspensions of mixed oocysts by the use of a micropipette. Individual oocysts were picked up and placed on a film of agar on a microscope slide. Their dimensions, and the presence of sporozoites inside the sporocysts, were checked under the microscope. They were then inoculated singly *per os* into coccidia-free chicks and oocysts were collected from the caeca seven days later. The weakness of this method for the primary isolation of a species is that it is difficult to be certain of the identity of the oocyst selected. Furthermore, as Tyzzer *et al.* (1932) also noted, only a small proportion of the chicks inoculated in this way become infected. The reason for this is not known.

Life Cycle of the Parasite

The life history of *E. necatrix* differs from that of the other intestinal species, in that first and second generation schizogony occurs in the intestine but the second generation merozoites migrate to the caecal epithelium to produce the sexual stages and oocysts. First generation schizonts were seen in the epithelial cells of the intestinal mucosa between 48 and 72 hours after infection. The liberation of first generation merozoites was followed by their penetration into adjacent epithelial cells which appeared to migrate more deeply into the mucosa and submucosa to form a colony of schizonts. Mature second generation schizonts were found at approximately 120 hours after infection. These schizonts when mature and sufficiently numerous, caused mechanical rupture of the mucosa with copious haemorrhages releasing the second generation merozoites. Third generation schizonts were found in sections of the caeca taken at the sixth day after infection. They were much smaller than those of the second generation and remained superficial in the caecal epithelium alongside cells containing the gametocytes which also appeared on the sixth day. Oocyst production started at 140 hours after infection, *i.e.* towards the end of the sixth day.

Oocyst Production and Sporulation

When compared with the other species of coccidia in chickens *E. necatrix* is a poor producer of oocysts (Brackett & Bliznick, 1952a). Tyzzer *et al.* (1932) remarked that they had difficulty in producing sufficient oocysts for experimental purposes. Similar difficulties have been encountered at Weybridge. If too severe an infection is set up there is a reduction in the numbers of oocysts which are produced. A possible explanation of this is that the loss of peristalsis in the intestinal wall and cessation of caecal function may prevent the migration of second generation merozoites down to the caeca. Satisfactory results have been obtained so far in five- or six-week-old birds infected with 12,500 sporulated oocysts, the caeca being removed to prepare oocyst suspensions on the 9th or 10 days after infection when large numbers of oocysts are present in the caecal epithelium. In this way cultures of up to 4.6 million oocysts per infected chick have been made.

Measurements of the oocysts of *E. necatrix* used in these experiments have indicated average dimensions of 20.5μ by 16.8μ, with a range of 15.5μ to 25.3μ in length and 13.6μ to 20.4μ in breadth.

Some difficulty has been experienced in the maintenance of sporulated oocysts of *E. necatrix* in the laboratory. Suspensions of oocysts in 2 per cent. potassium bichromate solution have been allowed to sporulate at room temperatures and in an incubator at 29° C. Complete sporulation of individual oocysts, as judged by infection experiments in susceptible chicks, has occurred in a minimum of 21 hours, and after two or three days 80 to 90 per cent. of the oocysts have sporulated. Some oocysts after sporulating successfully show slight distortion and cracking of the cyst wall. This tendency to rupture appears to be progressive during the period in which oocysts are stored at 5° C.

One culture when prepared contained 573,000 oocysts per ml. of which 81 per cent. were sporulated. After storage for one week it caused 100 per cent. mortality in an untreated group of 12 chicks, each of which had been infected at the rate of 130,000 sporulated oocysts per chick. After one month, during which it was stored as usual at 5° C., it had deteriorated and no deaths were recorded among a group of 15 chicks which had each received an estimated 100,000 sporulated oocysts. Minor adjustments in the methods of preparation of the suspensions and in the sporulation of the oocysts have not so far disclosed any errors in technique which might be responsible for the damage and loss of viability.

The Course of the Disease and *Post-mortem* Appearance

Following infection with sporulated oocysts of *E. necatrix* the first signs of disease were noted towards the end of the fourth day when chicks ceased to feed eagerly and became inactive. With heavy infections they rapidly deteriorated and passed quantities of watery faeces containing blood and mucus. In some cases death occurred before blood appeared in the droppings. Deaths continued over the fifth, sixth, and seventh days. With lighter infections, signs of ill health were noted on the fifth or sixth days but as the bowel haemorrhages were not so acute, deaths did not commence until the seventh day. Mild infections, in which no mortality was recorded, were detected by the presence of mucoid droppings and by the reduced weight gains of affected birds.

During the acute stage of a heavy infection, death was due to the multiple petechial haemorrhages which occurred over large areas of the intestine extending from a point immediately posterior to the gizzard, to the cloaca. These were caused by the rapidly maturing second generation schizonts which were seen as numerous rounded white spots in the wall of the intestine visible from the serous surface. The bowel wall was hyperaemic and thickened but was very fragile and ruptured easily even when carefully handled. In lighter infections the lesions were more

commonly confined to that portion of the intestine situated on either side of the yolk stalk.

Early in the infection intestinal peristalsis continued and blood was found in the caecal tubes, a condition which on cursory examination could be confused with caecal coccidiosis. The appearance differed, however, from that seen following infections caused by *E. tenella* in that the caecal wall was not thickened and normal caecal faeces could usually be found in the centre of the lumen, surrounded by a layer of blood. Later, caecal function was impaired, the caeca became shrunken and contained blood clots and hard dry caecal faeces. If the infection was not sufficient to cause death, the haemorrhagic phase subsided leaving a thickened, pale, rubber-like intestine showing white areas of schizonts, these indicating that schizogony was still continuing. Chicks at this time showed severe emaciation as if they had suffered from a long-standing chronic disease.

Pathogenicity of *E. necatrix*

To ascertain the numbers of oocysts necessary to cause consistent rates of mortality among susceptible birds, two groups of 20 three-week-old chicks were infected with 12,500 and 25,000 sporulated oocysts respectively. These levels of infection each resulted in a 10 per cent. mortality, deaths occurring on the 7th, 8th, and 10th days after inoculation. Subsequently, infection was increased to 50,000 and 100,000 sporulated oocysts and the effects were recorded in chicks of varying ages to verify the age resistance to *E. necatrix* described by Tyzzer *et al.* (1932). The results are given in Table I.

In the younger age groups a high rate of mortality occurred on the fifth, sixth, and seventh days. In the older age groups the majority of birds withstood the infections up to the sixth day, but thereafter a high mortality rate was recorded following infection with 100,000 oocysts, deaths being spread over a period of seven days. There were few deaths in the older birds which received 50,000 oocysts.

The Effect of *E. necatrix* on the Weight Gains of Susceptible Birds

To observe the reduced weight gains of birds infected with *E. necatrix* three groups of 20 six-week-old pullets were inoculated with 5,000, 10,000, and 20,000 sporulated oocysts respectively. An uninfected control group of 20 similar birds was kept in isolation.

The results are shown in Fig. 1. No mortality occurred at the two lower rates of infection but there were two deaths in the group which had been inoculated with 20,000 oocysts. The first signs of an adverse effect on the bodyweights were noted on the sixth day after infection and during the period of the observation birds in the infected groups did not regain the weight lost as a result of the damage caused by *E. necatrix*.

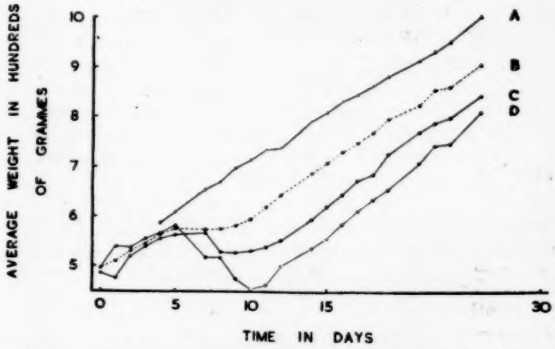

FIG. 1.—The lowered weight gains of six-week-old pullets infected with *Eimeria necatrix*. Four groups of 20 pullets. Group A uninfected, group B received 5,000 oocysts, group C 10,000, and group D 20,000.

TABLE I
THE EFFECT OF AGE ON MORTALITY DUE TO *Eimeria necatrix*

Number of birds	Age in weeks	Numbers of oocysts inoculated	Percentage mortality	Days after infection on which deaths occurred							
				5	6	7	8	9	10	11	12
10	2	100,000	100	8	1	1					
10		50,000	100	3	4	3					
10	3	100,000	100	4	3	3					
10		50,000	90	1	3	5					
20		25,000	10				1		1		
20		12,500	10			1			1		
10	6	100,000	100	2	5	3					
15		50,000	60		1	7			1		
15	8	100,000	100		3	10	1	1			
15		50,000	33			1		1	2	1	
10	14	100,000	70		1	2		2	1	1	
10		50,000	20					1			1
10	18	100,000	50		1	2	2				
10		50,000	0								
10	20	100,000	30			1	2				
10		50,000	0								

TABLE II

DEATHS FROM INTESTINAL COCCIDIOSIS, CAUSED BY *Eimeria necatrix*, DELAYED UNTIL THE 10TH DAY AFTER INFECTION BY FEEDING 1·0 PER CENT. SULPHADIMIDINE IN THE DRY MASH

Days after day of inoculation. Day 0

		0−2	0−1	0	0+1	0+2	0+3	0+4	0+5	0+6	0+7	0+8	0+9	0+10	0+11	0+12	Total mortality per cent.
		Deaths from acute *E. necatrix* infection															
Group 1 6 chicks	No treatment						—	—	—	5	1						100
Group 2 10 chicks	Treatment with 1 per cent. sulphadimidine in the dry mash from 0−2 to 0+4	...					—	—	—	—	—	—	—	3	1	1	50

Delayed Development of the Parasites

In the treatment of outbreaks of caecal coccidiosis caused by *E. tenella* occasional failures to control the disease were found to be due to the delayed development of the parasites following a single course of treatment of four or five days. Acute caecal coccidiosis reappeared in the flock a few days after the treatment had ended. The effect was demonstrated experimentally (Kendall & McCullough, 1952) by feeding 1 per cent. of sulphadimidine in the dry mash, a concentration of the drug in excess of that normally administered. The delayed development of *E. necatrix* following a single period of five days treatment is shown in Table II. Acute intestinal coccidiosis was noted on the sixth day after the birds had been returned to a normal diet.

The Effects on the Developmental Stages of *E. necatrix* of 24 hours' Treatment with 0.4 per cent. Sulphadimidine and 0.02 per cent. Pyrimethamine

Infection with *E. tenella* is most readily controlled when treatments are arranged to cause a maximum interference with second generation schizogony. At the same time the affected bird must be allowed to develop an immunity adequate to withstand subsequent exposure to infection. It is probable that similar conditions would have to be fulfilled in the control of intestinal coccidiosis caused by *E. necatrix*. It is essential, therefore, to obtain an accurate knowledge of the susceptibility of the various stages of the parasite to coccidiostatic drugs. Fig. 2 shows the effects on the developmental stages of *E. necatrix* of 24 hours' treatment with 0.4 per cent. sulphadimidine combined with 0.02 per cent. pyrimethamine, a highly effective synergic combination. Both drugs were fed in the dry mash to seven groups of 10 two-week-old chicks.

The results obtained with Group A, Fig. 2, suggest that the effects of the 24 hours' treatment were maintained for slightly longer than 24 hours. Deaths did not commence on the fifth day after infection as in the untreated control group, but were delayed until the sixth day.

Treatments covering the 24 hours before infection, the 24 hours after infection, and the period from the 24th to the 48th hour after infection, did not eliminate the early stages of the parasites which resumed their development after the drugs were withdrawn. Treatment from the 48th to the 72nd hours, however, had an adverse effect on first generation schizogony and caused a reduction in mortality to 30 per cent. Treatment during day three was even more effective. The parasites had been allowed to develop unchecked for the first 72 hours but there was then an interference with early second generation schizogony and deaths were reduced to 20 per cent. When treatment was delayed until the 96th hour there was still sufficient interference with second generation schizogony to give a moderate control of the infection. At 120 hours, treatment was too late to prevent the haemorrhages caused by the maturation of the second generation schizonts.

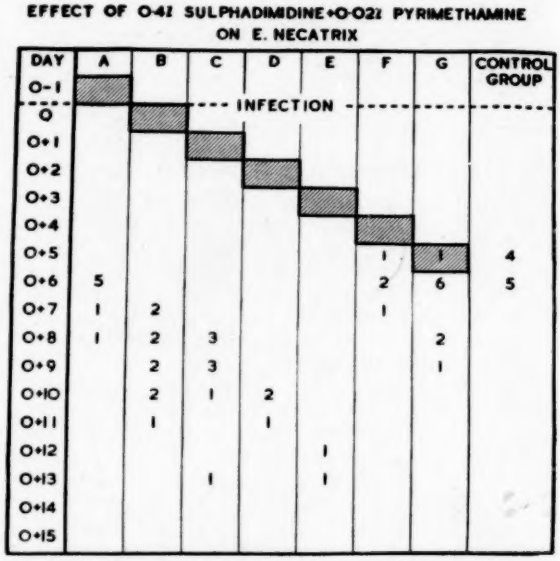

FIG. 2.—The effects of 24 hours' treatment with 0.4 per cent. sulphadimidine combined with 0.02 per cent. pyrimethamine on the developmental stages of *Eimeria necatrix*. Ten chicks per group. Shaded areas denote periods of treatment.

Discussion

The method used for the isolation of *E. necatrix* from intestinal lesions was successful in producing a pure culture of the organisms and it can be relied upon as a means of guarding against inadvertent infection of experimental birds with other species of coccidia, particularly *E. tenella*, *E. acervulina*, and *E. mitis*, which produce large numbers of oocysts and are liable to become contaminants.

Only minor differences were found in the life cycle of *E. necatrix* from the description recorded by Tyzzer *et al.* (1932). It appears that oocyst production

can commence on the sixth day after infection and the oocysts can sporulate in a minimum period of 21 hours. These figures are more in agreement with the recent findings of Edgar (1955). The average dimensions of the oocysts of *E. necatrix* recorded above also differ from the 16.7μ by 14.2μ given by Tyzzer *et al.* (1932) but agree closely with the 19.3μ by 16.5μ quoted by Becker *et al.* (1955). There is reason to suppose, therefore, that the average size of the oocysts of *E. necatrix* may be greater than has hitherto been recorded and that the range of dimensions of the oocysts overlaps that for the oocysts of *E. tenella*. When suspensions of the oocysts of *E. necatrix* and *E. tenella* were purposely mixed and examined microscopically, individual oocysts could not be identified with certainty. This probably explains why oocysts of *E. necatrix* were not identified in the samples of litter collected from poultry deep-litter units in Surrey and Hampshire by Davies & Joyner (1955).

The apparent low resistance of the oocysts of *E. necatrix* to the laboratory conditions described above and their loss of viability does not necessarily mean that under natural environmental conditions the oocysts would be similarly affected. Nevertheless, as other species of coccidia have been maintained in the laboratory far more satisfactorily than *E. necatrix*, there is at least a *prima facie* case for believing that it may be less resistant in the field.

It is clear that *E. necatrix* can give rise to an acute lethal form of intestinal coccidiosis in both young and old birds. Tyzzer *et al.* (1932) as a result of their experimental feeding of oocysts in a wet mash concluded that young birds were less susceptible to *E. necatrix* than older birds. They suggested that one reason for this was the greater length of the intestine in the older birds, which favoured the invasion of sporozoites. Brackett & Bliznick (1952b), however, found that young birds were highly susceptible. From the results recorded in Table I it appears that when birds of different ages are infected with similar numbers of oocysts the younger birds are more susceptible and moreover die at an earlier stage of the infection. In the older birds schizogony has to continue over a longer period until the intestinal mucosa has been sufficiently damaged to cause death from haemorrhage, or until the bird has become weakened and emaciated as a result of the loss of intestinal function. It may be that finding birds dead in this latter condition in the field has given rise to the belief that infection with *E. necatrix* is usually a chronic disease, whereas in the experiments reported above, if the infection is sufficient to cause death, this normally occurs not more than seven or eight days after the onset of symptoms. It is true, however, that the disease is not so precisely self-limiting as is caecal coccidiosis caused by *E. tenella* for scattered colonies of second generation schizonts of *E. necatrix* have been found in the intestine 28 days after infection.

In field outbreaks of intestinal coccidiosis caused by *E. necatrix*, older birds are more usually involved than in outbreaks of caecal coccidiosis but it is probably the lower oocyst production of *E. necatrix* and possibly the poor viability of the oocysts which account for the delay in the appearance of outbreaks. If the environment is unsatisfactory for oocyst development and survival the flock may still pick up small numbers of oocysts which, as was demonstrated in Fig. 1, can result in an appreciable weight loss without other obvious symptoms of disease. Moreover light infections are potentially dangerous in that they are responsible for the further production of greater numbers of oocysts. Once circumstances favourable to the build-up of populations of oocysts have been established, clinical disease is likely to follow. Where such a build-up is prevented by efficient husbandry and flock management, losses from intestinal coccidiosis caused by *E. necatrix* will be reduced to a minimum, but when the normally accepted standards of hygiene are modified to suit present-day methods of intensive poultry keeping, there may be strong arguments in favour of the continuous use of an effective coccidiostatic drug to reduce the possibilities of disease.

It is evident from the results shown in Table II and Fig. 2 that the control of outbreaks of disease can be successful, for losses following infection were reduced when treatment was arranged to cause a maximum interference with the second generation schizonts which appeared to be the most susceptible stages of the parasite. Treatment, moreover, may still be relatively effective even when it is delayed until the fourth day after infection. The early developmental stages of the parasite appear to be more resistant to the effects of drugs, and treatment affecting these may lead to delayed clinical symptoms of coccidiosis. It is probable that, as with *E. tenella* (Davies & Kendall, 1954), best results will be obtained with an interrupted form of treatment.

Summary

1. Pure suspensions of the oocysts of *E. necatrix* were prepared after isolation of the parasite from natural mixed infections.

2. Observations on the life cycle of *E. necatrix* agreed closely with the description recorded by Tyzzer *et al.* in 1932. There were, however, some observed differences in the prepatent period, the minimum period of sporulation, and the average size of the oocysts.

3. *E. necatrix* was found to be capable of producing an acute haemorrhagic form of intestinal coccidiosis, young birds being most severely affected.

4. The effects of a highly active combination of 0.4 per cent. sulphadimidine with 0.02 per cent. pyrimethamine on the various developmental stages of *E. necatrix* are recorded, and the possibility of successful control is discussed.

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Failure to Produce Urinary Calculi in Kittens by the Addition of Mineral Salts, Derived from Bone-meal, to the Diet

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AS the result of a questionnaire circulated in the United States of America, Morris (1953) stated that veterinary opinion was unanimous that cats should receive a diet with a low ash content in order to prevent urinary calculi. Since the ash content of the basal diet used in experiments described previously (Dickinson & Scott, 1954) was 9·1 per cent. of the dry weight (3·8 per cent. on a wet weight basis) it seemed desirable to study the effects of a high mineral intake on kittens.

Experimental

The weanling kittens used in the experiments described below were bred and reared under standardised conditions in this laboratory where a breeding colony of cats has been maintained for six years. The kittens were selected and housed in groups in specially designed cages as described for previous experiments (Dickinson & Scott, 1954). They were weighed and examined three times weekly.

The experimental diets were similar in constitution to the high-protein basal diet described previously (Dickinson & Scott, 1954). The mineral content of Diet I, 8·43 per cent. of the dry weight, was the lowest level of mineral content used in these experiments (Table I). The higher mineral levels of Diets II and III, 21·9 and 30·1 per cent. of the dry weight respectively, were produced by replacing increased amounts of Diet I with mineral salts derived from bone-meal.

It will be seen from Table I that although the protein content (N × 6·25) of 53 per cent. in Diet I, was reduced to 43 per cent. in Diet III, this lower level was found previously to support satisfactory growth in weanling kittens (Dickinson & Scott, 1956).

Ordinary tap water was provided as drinking water; the mineral intake was little affected by this as the concentration in the diets was extremely high.

Experiment 1.

Twelve kittens representing four litters, the average age of which was seven weeks, were arranged in three groups and fed for 11 weeks on the test diets I, II and III shown in Table I.

Experiment 2.

Four kittens from litters of average age eight weeks were arranged in pairs and fed for 10 weeks on Diets I (two ♀ kittens) and III (two ♂ kittens) respectively. The latter pair (two ♂) were fed Diet II for a further 14 weeks. Records of diet consumption were kept and at the end of the experimental period the animals were sacrificed. At *post-mortem* investigations the kidneys and urinary tracts were examined and the kidneys weighed. The kidneys and ureters were examined histologically.

Results

The mean weight gains of the three groups of kittens used in the first experiment are shown in Fig. 1. There was little difference between the weight gains of those receiving Diets I and II, while those receiving Diet III gained weight at a slower rate. It is probable that the kittens on Diet III did not receive sufficient food to satisfy their calorific requirements. X-rays of the

TABLE I.
ANALYSIS OF EXPERIMENTAL DIETS (DRY WEIGHT)

Constituent	Diet I	Diet II	Diet III
Total ash	8·43	21·86	30·07
CaO (Ca)	2·21 (1·58)	7·81 (5·58)	11·29 (8·07)
P_2O_5 (P)	2·72 (1·19)	9·90 (4·32)	14·19 (6·19)
MgO (Mg)	0·050 (0·030)	0·019 (0·011)	—
Fe_2O_3 (Fe)	0·092 (0·062)	0·211 (0·143)	2·098 (1·016)
Na	0·885	0·972	0·817
K	0·644	0·536	0·318
Cl	0·092	1·694	1·64
I	0·006	0·022	0·021
Protein (N × 6·25)	53·1	43·9	43·1
Fat	9·7	•	•
Dry weight as per cent. diet	28·2	31·7	32·7
Ca : P ratio	1·32	1·29	1·30
Cals. per 100 g.	135	•	107

• Not estimated.

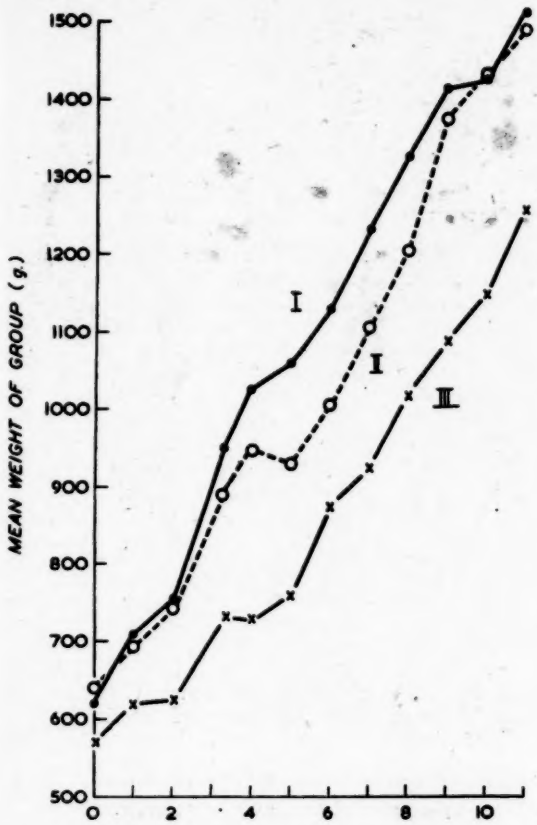

Fig. 1. Experiment 1. Mean weight gains of groups, each containing four kittens, receiving the experimental diets I, II and III shown in Table I.

fore-paws were carried out on representatives from each group and showed normal bone formation.

During the period of the second experiment the kittens on Diet III ate an amount which brought their calorific intake almost up to the level of those on Diet I. As a result of this there was no difference between the weight gains of the pairs. No detrimental effects of the high m neral intake were observed ; the general condition of the kittens, which were lively and vigorous, was extremely good, their coats thick and glossy and their eyes clear and bright.

At *post-mortem* examination, the weights of the kidneys of kittens fed on the higher level of mineral were found to be within the normal range for their bodyweight (Hall & MacGregor, 1937). Histological examination showed all the urinary tracts to be normal.

Discussion

In a description of clinical conditions occurring frequently in cats Parker (1938) states that calculi are common in old neutered male cats. The incidence of calculi is also reported to be higher in the males of cattle and sheep.

Experimental work which has been carried out on sheep, rats and dogs suggests that the factors, including sex, which affect the incidence of calculi, may vary with the species.

For rats and dogs, Higgins (1951) found that vitamin A deficiency was associated with the formation of calculi, and Watchorn (1932) found that excessive dietary magnesium increased the incidence of calculi in rats, especially females.

In contrast, for sheep, although the evidence is conflicting, neither vitamin A deficiency (Beeson, Pence & Holm, 1943) nor increased dietary magnesium (Johnson, Palmer & Nelson, 1940) appear to be involved in the production of urinary calculi. However, Lindley, Taysom, Ham & Schneider (1953) found a high incidence of calculi in ram lambs which at one month after weaning were fed a diet supplemented with phosphate.

Although the total mineral contents of all three diets used in our experiments were extremely high, the Ca : P ratio was almost constant in all of them (see Table I). The magnesium content was not high in Diet I, the proportion was decreased in Diet II and was not measurable in Diet III ; the iron content rose from Diet I → II → III.

It is apparent, therefore, that a high, balanced level of calcium and phosphorus in the diet can be tolerated by young entire kittens of either sex and does not induce the formation of urinary calculi. In elderly castrated toms it is probable that metabolic and endocrine factors predispose towards this condition, which might also be brought about by an unbalanced mineral intake, as in the experiments on sheep and rats mentioned above.

Summary

Two experiments are described in which diets containing three levels of mineral salts derived from bone-meal were fed to groups of entire growing weanling kittens of both sexes. The only difficulty encountered was to ensure that the kittens on the high mineral diets received a sufficient calorie intake. In all other respects the kittens grew well, were healthy, and showed no macroscopic or microscopic abnormality of the urinary tract.

Acknowledgment.—This work was undertaken in co-operation with Dr. R. G. Booth and Mr. A. J. Harms of Messrs. Petfoods Ltd. The authors would like to thank Miss O. Cornelius for assistance with the animals.

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All in a Day's Work

BY
J. E. JOHNSON
Leicester

IT had been one of those Saturdays when everything that could go wrong, did so. Old Thompson's Jersey cow with milk fever had me up at 6.30 a.m. and there was my car with a flat tyre. During the morning surgery, Joe brought his terrier along with its annual impaction of the rectum. During the relieving process most of the impacted mass, and the accumulated fluid dammed back by that mass, were generously sprayed over my newly cleaned flannels. After that two of my calls were to farms which I always consider the tenants should have rent free: they are out in the wilds with a very much unadopted road, and at least six gates to open.

Eventually I arrived home for supper about 9 p.m. and had no sooner sat down when my thoughts were suddenly interrupted by the phone. It was a call from a lady who announced herself as "Jessie" of the . . . Inn. One of her two pigs had died suddenly, and as her other pig might be in danger she would like me to go that night. I went.

Arriving at the Inn I found a rough road leading up one side of the building into what appeared to be a yard-cum-garden. I took the car up this road and was surprised to find myself in a sort of beer garden. There was quite a crowd of people. Mothers and fathers with children, young men with sweethearts, and one or two groups of young ladies no doubt with the sweetest of hearts also.

Affecting to ignore the stares of the entire company I proceeded to change into rubber boots. Now it so happens that the old pair of socks which I always carry in my Wellingtons were badly in need of repair at the heels. I put on one of these socks and faintly heard a small boy saying, "Eh, Ma, look at hole in that man's sock!"

As I put on my second sock the same voice, with more astonishment, exclaimed, "Ma, there's a hole in t'other."

I tried to look as though I hadn't heard. The child's mother in fetching it a well-merited clump on the head upset her beer. Her objurgations put her offspring's howling in the shade.

I now enquired for my client, the landlady, and was shown into the kitchen. There, at an old-fashioned square table, sat "Jessie." She was short and plump and rested a pair of well-covered arms on the table. Sitting on her right, enjoying a pint of bitter was a police sergeant, and as I went towards the table I realised a police constable was using the phone in the corner.

I asked what was happening. As Jessie cleared her throat I glanced down at the table and saw a Swine Fever form, all filled in and served on my hostess. The latter then related how the pig was found dead. She had called in the farmer from whom she had bought it eight weeks ago but he had consoled her by claiming the pigs were healthy when he sold them. Then half the regulars in the bar had said she should report the death to a "Vet," the others said the police should be informed. So she decided to report to both. The constable on the phone was awaiting a reply from the Divisional Inspector of the Ministry so I suggested that I might be allowed to speak to him. Instructions were then given for me to proceed.

To my horror I was told that the pig was in a garage in the yard.

"Not the yard where all those people are drinking?" Jessie said she was afraid it was, and that the live pig was still with it. I suggested that the live pig might be moved to another place, but she said that was impossible: there was no other place but the yard at present occupied by her customers.

I was taken, by the two policemen, to this garage. The doors had been removed and wood boarding, 3 feet high, was nailed across the entrance. The police showed no signs of movement when I suggested that we had better get the dead pig out, so I asked them to approach Jessie for assistance. Within a couple of minutes a sturdy, middle-aged man appeared. "Where's this pig, Vet?" he asked. I showed him and he quickly glanced at the carcase.

"Inflammation . . . that's what that is," he said.

A rope was obtained and I asked my new assistant to climb into the pen and tie the dead pig's hind legs together. The live pig was delighted to see him and displayed considerable interest in the whole proceedure. I asked for the other end of the rope, so he proceeded to look for it. Carefully, he followed the rope from where it was tied to the dead pig, one hand at a time, until he found the end we wanted. It was in the mouth of the live pig. Having obtained complete control, he came towards me and gave a hefty pull. With a thud he fell flat on his back. He had omitted to tie the rope he had so carefully wrapped around the hocks of the carcase. The second effort was more successful and we managed to get the pig over the wood boarding and secured it against a brick wall outside.

All this time every eye in the yard was on us. I proceeded with my *post-mortem* examination. Several small girls and their mothers or sisters kept coming past and peeping at my efforts.

At last I exclaimed, "Can't you keep these females away from here, Sergeant?" He said, with a grin, "You've got him up against the ladies' lavatory wall." I looked as dignified as I could—which wasn't very—and got on with it.

In Brief

REPRODUCTIVE PHYSIOLOGY

In the field of veterinary reproductive physiology, studies of considerable fundamental importance have been made into the blood cytology at parturition and during the phases of the oestrous cycle. The definite change which occurs at calving has been shown to be associated with an alteration in the level of circulating antibody which may influence the animal's immune reactions, *e.g.* its ability to react to the tuberculin test (Kerr *et al.*, 1946). Similar, but less marked, changes occur at oestrous (Moberg, 1953). These cyclical changes in the blood cytology are believed to be mediated by the hormones of the adrenal cortex and there is little doubt that the changes have a definite function in the phenomenon of homeostasis. For example, parturition and oestrous are both times of stress in which there is a risk of infection of the genital tract and the blood changes which are present at these times seem particularly well suited to guard the genital tract against possible infection. The practical deduction from this is that oestrogens act as " disinfectants " of the genital organs. On the other hand, when the animal is in the luteal phase of its reproduction cycle, *viz.* dioestrous and pregnancy, its genital tract is particularly prone to infection. Thus insemination during dioestrous or pregnancy may lead to pyometra (Rowson *et al.*, 1953). Persistent corpora lutea and luteinised cysts are, in the same way, conducive to pyometra.

On the male side of reproductive physiology a useful contribution has been the practical application to the bull, of electrical ejaculation (Thibault *et al.*, 1948). Thus semen may be collected without a " teaser " cow and irrespective of the bull's desire or ability to mate. Another advance has been the development of the " deep-freeze " method of storage of semen in which, by adding glycerol, semen may be reduced to −79° and its fertilising capacity thus retained—apparently for years (Polge *et al.*, 1949; Polge & Rowson, 1952). This will make possible international exchange of semen, the preparation of semen banks, and will further the usefulness of the proven bull.

In the porcine field a technique of collecting and storing semen has now been developed and this has made possible A.I. in this species also.

Infertility

In respect of the subject of bovine infertility, in recent years, two main trends have emerged. First, in regard to *infectious infertility*, trichomoniasis has become much less troublesome but genital vibriosis has been found to be widespread and to be transmitted venereally (Lawson & McKinnon, 1952). Thus the control of vibriosis is on the same lines as those previously applied for trichomonas disease—with particular care to see that bulls at A.I. centres are not carriers. The other main fact which has evolved from studies of reproductive failure is that *functional infertility* is on the increase, that few herds are free from it, and that it probably has a genetic basis. There has, in this connexion, been a welcome trend of thought, *viz.*, to regard functional infertility as a defect of the endocrine system rather than as a purely ovarian dysfunction *per se* (Garm, 1949). As a result, there has developed a more sceptical approach to the treatment of functional infertility. In repeat-breeders free from infection or structural deformity, progesterone implants may make good a natural deficiency which has caused early resorption or abortion (Dawson, 1954). The connexion between functional reproductive states and infection has already been touched on. In respect of a well-recognised structural cause of infertility, *viz.*, obstruction of the Fallopian tubes, a new method of diagnosis of tubal patency which promises well, involves the intraperitoneal injection of soluble starch and the identification, by means of the iodine reaction, of starch grains in vaginal smears.

G. H. ARTHUR (December, 1955).

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CIBA FOUNDATION AWARD

The Ciba Foundation is offering not less than five awards, of an average value of £300 each, for papers on research relevant to basic problems of ageing. In making the awards, preference will be given to younger workers. The work submitted should not have been published before May 31st, 1956, and the paper, which may be in the candidate's own language, should not be more than 7,000 words in length, with a summary in English not exceeding 3 per cent. of the paper. Entries must be sent in not later than January 31st, 1957, to the Ciba Foundation, 41, Portland Place, London, W.1, from which application forms and further information can be obtained.

CAMBRIDGE UNIVERSITY VETERINARY SCHOOL

The Council of the Senate have informed the University that the Treasury have approved a grant of £47,246 for the Veterinary School (additional costs and animal house), recommended by the University Grants Committee.

News and Comment

CONFERENCE ON SHEEP

A conference on sheep, at which Dr. J. R. Holmes of Bristol University was a principal speaker, was held at Ludlow last week. There was a great future for sheep on the general farm, said Mr. T. C. Morgan, the chairman. Modern science was " removing much of the mysticism which shrouded the shepherd's activities for so many centuries." There was no threat of over-production—at least for some years to come.

Dr. Allan Fraser, lecturer in Animal Husbandry, Aberdeen University, spoke on " Sheep Management and Nutrition." He said that, in 1939, 50 per cent. of the mutton and lamb consumed in Britain was home produced, but to-day we only produced 33 per cent. of our requirements. There was a great deal of leeway to make up. Discussing some of the problems likely to be met during the breeding cycle, Dr. Fraser said that the present-day system of " flushing " the ewe flock before tupping, undoubtedly increased the number of twin lambs.

Dr. Holmes spoke on " Some Deficiency Diseases of Sheep." Pregnancy toxaemia was world-wide in its distribution and only affected pregnant ewes. It usually appeared between the 16th and 17th week of pregnancy and, while in some flocks only a single case might occur, in others up to 25 per cent. of the ewes were affected. Early symptoms were dullness, failure to graze, and frequent grinding of the teeth with a marked loss in condition. At times there was a strong, sickly-sweet odour of acetone in the breath. The head might be held high and a staggering gait was sometimes noticeable. Except where ewes were attacked within a few days of parturition, and lambed shortly after the onset of the disease, the mortality was high, often exceeding 90 per cent. Recent observations on 29 flocks suffering from pregnancy toxaemia had shown that only two flocks were receiving concentrates and the speaker felt that, while in no way minimising the value of hay and roots, concentrates were particularly valuable as a preventive measure during the gestation period.

For lowland flocks supplementary feeding should be continued daily. When feeding concentrates it was essential to provide adequate trough space otherwise the barren ewes obtained more than their fair share as they always reached the trough first. An increasing plan of nutrition should be given during the gestation period, while it was imperative that in-lamb ewes obtained sufficient exercise.

UNIVERSITY NEWS

Liverpool

When Liverpool University Court met on November 26th, it was announced by Lord Leverhulme (member of the University Council and Chairman of the organising committee of the Appeal Fund) that the Appeal made five months ago for a £500,000 Building Fund had already reached £608,000. Lord Leverhulme said: " The Appeals Committee are not only well satisfied with the magnificent response this appeal has met with, but are deeply touched by the fact that this university is held in such affection and esteem by such a very wide circle of friends. Support has come not only from industry and commerce, but also from a very large number of individuals, and in particular members of Senate, present students, and many of our graduates." Declaring that it had been decided not to close the Appeal Fund, Lord Leverhulme gave two reasons for the decision. The first, he said, was that they had reason to believe that further contributions would be received. The second was that with £500,000 they could tackle only the most important of their building projects.

Referring to these building projects, the Vice-Chancellor, Sir James Mountford, has stated that the erection of a new building for the Veterinary Faculty will begin in 1959.

ABUSE OF CHARITY

At the Annual Meeting of the West Cornwall branch of the R.S.P.C.A. held at Helston, recently, the branch hon. secretary said there seemed to be an impression abroad that if anyone had an animal to be destroyed, all he had to do was to contact the branch inspector. The R.S.P.C.A. service was being very much abused. A lot of people made use of it for nothing who could very well afford to pay a veterinary surgeon. There was no reason why the R.S.P.C.A. should provide free service unless it was a case of genuine need and for the prevention of cruelty to animals.

RECORD FOR FRIESIAN HEIFER CALF ?

A Friesian heifer calf, born last week, near Oswestry, Salop, is said to have weighed 172 lb. The owner, Mr. F. G. Hitchen, believes this may be a record in Britain.

IN PARLIAMENT

Slaughterhouses (Horses)

MR. CHAPMAN (November 29th) asked the Minister of Agriculture, Fisheries and Food, whether the 21 horse slaughterhouses and knackers' yards which, three months ago, were still below the standards fixed by the 1954 Regulations, now comply fully with the regulations.

MR. AMORY: Of 21 premises known three months ago to be sub-standard, 14 now comply fully with the regulations and three have closed. The local authorities concerned are taking action about the remaining four.

Cattle Exports

LIEUT.-COL. BROMLEY-DAVENPORT asked the Minister of Agriculture, Fisheries and Food whether he is aware of the continued anxiety felt by large sections of the public over the increasingly large traffic in live cattle from the United Kingdom to the Continent; whether he is aware that, in spite of

regulations and the efforts of animal societies, many animals suffer considerable hardship; and whether he will have special inquiries made into the position with a view, if necessary, to seeking powers to enable him to have such animals slaughtered here and the carcases sent abroad.

MR. AMORY: I am aware that this traffic is arousing some public anxiety, and I am having it closely watched. In addition to the investigation at Richborough, to which I referred in my reply to the right hon. Member for Rochester and Chatham (Mr. Bottomley) on November 22nd, I arranged for one of my senior veterinary officers to travel recently with a consignment of cattle from this country to Holland. He found on the whole that the cattle were well and sympathetically handled, they travelled in reasonable comfort, and were none the worse for the crossing. There were satisfactory arrangements for feeding and watering at both ends of the voyage, and food and water were also available on board. I am grateful to the Dutch authorities for allowing my officer to visit some abattoirs where British cattle are slaughtered; he found the conditions and equipment there very good.

Foot-and-Mouth Disease

MR. HURD (November 29th) asked the Minister of Agriculture, Fisheries and Food, in view of the fact that scientific investigation by his Department has shown that the virus of foot-and-mouth disease is preserved by cold and destroyed by heat, if he will test the practicability of requiring the flash heating of Argentine meat before it is chilled or frozen for shipment to the United Kingdom.

MR. AMORY: I am advised that although flash heating might destroy surface contamination, it would not destroy the virus of foot-and-mouth disease in an infected carcase where it may be present throughout the meat and the bone marrow.

MR. HURD: Will my right hon. Friend please not be deterred by that advice because the modern infrared rays have a wonderfully penetrating effect, and it could do no possible harm to try this out on half a dozen carcases of infected meat?

MR. AMORY: I will certainly bear in mind what my hon. Friend has said.

MR. DYE asked the Minister of Agriculture, Fisheries and Food how many outbreaks of foot-and-mouth disease have occurred amongst farm animals this year in England and Wales; what has been the source of infection; and how it was brought into the areas infected.

MR. AMORY: There have been 144 confirmed outbreaks of foot-and-mouth disease in England and Wales this year of which 23 are classified as primaries. In many of the primary cases infection is attributed to direct or indirect contact with raw meat or bones from South American carcases distributed through normal trade channels. In the others the origin is obscure.

MR. DYE: In view of the fact that the cause of these outbreaks is imported meat, will not the Minister make it an offence to import into this country meat infected with foot-and-mouth disease? Or will he arrange effective examinations at the port in order to prevent this meat from being imported.

MR. AMORY: Every possible precaution that we can think of is taken at present. We have veterinary officers of our own in South America who inspect the arrangements for inspection and themselves inspect many of the carcases by sampling, but however efficient the check by inspection is made, it cannot entirely eliminate the risk of the transfer of the disease.

Fowl Pest, Norfolk

MR. DYE (November 29th) asked the Minister of Agriculture, Fisheries and Food how many outbreaks of fowl pest have occurred in Norfolk so far this year; how many birds and eggs have been destroyed; and his estimate of the cost in dealing with these outbreaks and the amount of compensation to be paid.

MR. AMORY: Up to November 27th there have been 26 outbreaks of fowl pest this year in Norfolk, involving the slaughter of 106,575 birds and the destruction of 16,542 hatching eggs. Compensation amounts to about £134,000.

MR. DYE: Is the Minister aware that these recent outbreaks of fowl pest have been of such a mild character that the owners and those looking after the birds have not noticed it, and that it has been detected only by blood tests and laboratory examinations? Is it not quite a different disease from that with which we were dealing a few years ago?

MR. AMORY: The hon. Member may have more information about this than I have, but I understand that the serious outbreaks recently in Norfolk have been among ducks, and I am advised that in ducks the disease is extremely difficult to diagnose. That is why it is serious, because it can be conveyed by ducks just as easily as by poultry.

MR. G. P. MALE, O.B.E.

As briefly mentioned in our issue last week Mr. George Percy Male, O.B.E., M.R.C.V.S., of Westcroft, Earley, passed peacefully away on Thursday, November 29th, after a long illness.

He qualified in 1902 at the Royal Veterinary College, London, and was actively engaged in practice in Reading for 50 years which he celebrated, together with his golden wedding, in December, 1955.

He held many important appointments during his distinguished career both in his profession and in other spheres. He was President of the Royal College of Veterinary Surgeons in 1931 when he had the privilege of welcoming the Duke of Gloucester as the guest of honour at the annual banquet. He was a member of the Council until 1951. Mr. Male was President of the British Veterinary Association in 1929, President of the International Veterinary Congress, 1930, and a Governor of the Royal Veterinary College for many years.

In 1905 he was appointed Lecturer in Veterinary Science at Reading University in its original buildings near The Forbury, a post which he held until 1944. He was also a lecturer in veterinary science at Oxford University during the year 1920-1.

During the First World War he was veterinary officer to units of the Yeomanry R.A.S.C. and R.E. stationed near Reading, and commanded two large veterinary hospitals.

For many years he was consulting veterinary surgeon to the Royal Counties Show, the Bath and West Show, and numerous local agricultural shows at which he was such a well-known figure. In addition to being veterinary surgeon to many of the cattle breed societies, he was a consulting veterinary surgeon to the Ministry of Agriculture for examination of stallions.

Mr. Male was a keen sportsman and hunted for many years with the South Berks and Garth hounds, and with numerous other packs. In 1929 he became Joint Master of the South Oxfordshire Drag Hounds. He was a member of the South Berks Hunt Committee until his death, and in his early years was a successful rider in point-to-point races, a show jumper and exhibitor of hunters.

Throughout his life his one love was the horse, and he became one of the leading consultants in addition to being a well-known judge of Hunters, Shires, Hackney Ponies, and Jumpers.

For his devoted work on behalf of the Royal College of Veterinary Surgeons and the veterinary profession he was honoured in 1951 by King George VI and was awarded the Insignia of the Order of the British Empire.

He leaves a widow, a son, and three granddaughters.

The funeral service was held at St. Peter's Church, Earley, on Tuesday, December 4th, 1956.

PERSONAL

Birth

SANDERSON.—On November 29th, 1956, to Margaret (*née* Cooper, B.SC.) and John Sanderson, M.R.C.V.S., of South Leylodge, Kintore, Aberdeenshire, a son.

R.C.V.S. OBITUARY

MOODIE, Robert Robertson, 1, Inkerman Terrace, Rothesay, Bute. Qualified Glasgow, July 7th, 1920. Died November 29th, 1956, aged 62 years.

Memorial Service

SIR LIONEL WHITBY.—A memorial service for Sir Lionel Whitby, Master of Downing College, Cambridge, was held on Saturday, December 1st, at Great St. Mary's, Cambridge. Professor L. P. Pugh represented the Royal College of Veterinary Surgeons, and Dr. Peter Storie Pugh attended on behalf of the Queen's Own Royal West Kent Regiment and the Governors of the United Cambridge Hospital.

COMING EVENTS

December

12th (Wed.). General Meeting of the Midland Counties Division at the Birmingham Medical Institute, 154, Great Charles Street, Birmingham, 2.30 p.m.

Ordinary General Meeting of the Sussex Veterinary Society at the Adelphi Hotel, Brighton, 2.30 p.m.

13th (Thurs.). Special Meeting of the Herts and Beds Veterinary Society at 70, Holywell Hill, St. Albans, 7.30 p.m.

Meeting of the East Midlands Division at the Nottingham University School of Agriculture, Sutton Bonington, 2.30 p.m.

14th (Fri.). Annual Dinner Dance of the North Wales Division at the St. George's Hotel, Llandudno.

Ordinary General Meeting of the South Wales Division at the Park Place, Cardiff, 2.15 p.m.

General Meeting of the North of England Veterinary Medical Association in the Agricultural Lecture Room, King's College, Newcastle upon Tyne, 2.30 p.m.

19th (Wed.). Meeting of the Section of Comparative Medicine, Royal Society of Medicine, at the Society's House, 5 p.m.

20th (Thurs.). Annual Dance of the V.V.B.F. Ladies' Guild, Dumfries Division, in the Cairndale Hotel, Dumfries.

Ordinary General Meeting of the South-Eastern Veterinary Association at the Royal Star Hotel, Maidstone, 2.30 p.m.

January

3rd (Thurs.). Meeting of the Supplementary Veterinary Register Division at 7, Mansfield Street, London, W.1, 2 p.m.

24th (Thurs.). Annual Dinner and Dance of the V.V.B.F. (Northern Division) in the Northern Hotel, Aberdeen, 7.30 p.m.

BRITISH VETERINARY ASSOCIATION QUARTERLY MEETINGS

Wednesday, January 23rd, 1957, at 7, Mansfield Street, W.1.

10.00 a.m. Parliamentary and Public Relations Committee.
11.30 a.m. Veterinary State Medicine Committee.
2.00 p.m. Small-Animals Committee.

Thursday, January 24th, 1957, at 7, Mansfield Street, W.1.

10.00 a.m. Farm Live-stock Committee.
11.30 a.m. Home Appointments Committee.
12.30 p.m. Finance Sub-committee.
2.30 p.m. General Purposes and Finance Committee.

Friday, January 25th, 1957, Connaught Rooms, Great Queen Street, W.C.2.

10.30 a.m. Extraordinary General Meeting followed by Council Meeting.

FOOT-AND-MOUTH DISEASE

The areas described in the schedule below are declared to be Infected Areas for the purpose of preventing the spread of foot-and-mouth disease :—

The Administrative County of the Isle of Wight.

IN THE COUNTY OF ESSEX

The Boroughs of Chelmsford and Romford.

The Petty Sessional Divisions of Billericay, Brentwood, Orsett and Romford.

In the Petty Sessional Division of Ongar: The parishes of Willingale, Norton Mandeville, High Ongar, Blackmore, Stondon Massey, Kelvedon Hatch and Navestock.

In the Petty Sessional Division of Chelmsford: The parishes of Roxwell, Writtle, Highwood, Margaretting, Ingatestone and Fryerning, Stock, Springfield, Little Baddow, Danbury, Saudon, Great Baddow, West Hanningfield, East Hanningfield, Woodham Ferrers and Rettendon and so much of the parishes of Runwell and South Hanningfield as lies within the Petty Sessional Division.

In the Petty Sessional Division of Rochford: The parishes of Hockley, Rawreth, Rayleigh, Thundersley, South Benfleet, Hadleigh and Canvey Island.

In the Petty Sessional Division of Dengie and Maldon: The parish of Stow Maries and so much of the parishes of Purleigh and Cold Norton as lies to the west of the road running from Woodham Mortimer via Rudley Green, Howegreen and Great Canney to Stow Maries including the said road.

IN THE COUNTY OF KENT

The Boroughs of Deal, Dover, Folkestone and Sandwich.

In the Petty Sessional Division of Hythe and Romney Marsh: The parishes of Acrise and Hawkinge.

In the Petty Sessional Division of Wingham and Sandwich: The parishes of Worth, Woodnesborough, Staple, Goodnestone, Eastry, Adisham, Aylesham, Nonington, Northbourne, Sholden, Sutton, Tilmanstone, Eythorne, Womenswold, Barham, Sibertswold, Denton, Wootton, Coldred, West Langdon, Ripple, Ringwould, St. Margaret's at Cliffe, East Langdon, Guston, Whitfield, Temple Ewell, Lydden, Swingfield, Alkham, Capel le Ferne, River and Hougham Without.

ADDRESSES OF DISEASE INFECTED PREMISES

The list given below indicates, first the county in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

Anthrax

Ayr. Slatehole Farm, Ochiltree, Cumnock (Nov. 26).

Derby. Corn Park Farm, Mayfield, Ashbourne (Nov. 26).

Devon. Shutebridge Farm, Aylesbeare, Exeter (Nov. 26).

Durham. Dove Hall Farm, Bowes, Barnard Castle (Nov. 28).

Hants.—Pilcot Farm, Dogmersfield, Basingstoke (Nov. 29).

Sussex.—Chequer Tree Farm, Wickhurst Lane, Broadbridge Heath, Horsham (Nov. 28).

Fowl Pest

Bedford. 15, Park Lane, Eaton Bray, Dunstable (Nov. 26).

Essex. 30, Straight Road, Boxted, Colchester (Nov. 26).

Lancs. Catteralls Farm, Lewth, Woodplumpton, Preston; Bradiner House Farm, Grimsargh; North View, High Barn Lane, New Longton, Preston (Nov. 26); Roman Road Farm, Grimsargh; Mayfield House, Catforth; Berrys Farm, Elston; Willow Nook Farm, Eaves, Woodplumpton; Willacy House Farm, Catforth; Moorville Poultry, Woodplumpton; Hawthorne House, Out Rawcliffe; Meadowside, Ratten Lane, Hutton; Rouse Acre, Tag Lane, Ingol; Cottam Lodge, Cottam; Myre Pole, Eaves, Woodplumpton; Holmlea Poultry Farm, Blackleach Lane, Catforth (Nov. 27); Gracemire Farm, Salwick; Roberts House Farm, Osbaldestone, Blackburn; The Hermitage, Ferny Halgh Lane, Haighton, Grimsargh; Shepherds Hill Farm, Fulwood; Stockbridge Cottage, Park Lane, Forton; Crane Hall Farm, Out Rawcliffe; Newton Leigh, Hambleton; Whiney Cottage Farm, Woodplumpton; 104, Bispham Road, Carleton, Blackpool (Nov. 28); Beech House, Catterall; Moss Side Farm, Stalmine, Fleetwood; Higher Hill House, Lewth, Woodplumpton; 626, Leyland Lane, Leyland; Hutton Manor Hutton (Nov. 29).

Yorks. The Square Works, Mytholmroyd (Nov. 27).

Swine Fever

Bucks. Seven Hills Farm, Iver Heath, Iver (Nov. 30).

Ches. Grange Farm, Bramhall, Stockport (Dec. 3).

Durham. Scotts House Farm, West Boldon, East Bolden (Nov. 26).

Glamorgan. Tylcha Farm, Tonrefail, Porth (Nov. 26); Tynycacau, Llandow, Cowbridge (Nov. 29).

Lancs. Hoole Fold Farm, Barton, Preston (Nov. 29).

Leics. Ashby Road Farm, Breedon-on-the-Hill (Nov. 27).

Salop. Wolverton Farm, Church Stretton (Nov. 27).

Staffs. 92, Franchise Street, Kings Hill, Wednesbury (Nov. 29); Home Farm, Walsall Road, Great Wyrley, Walsall (Dec. 3).

Warwicks. Pear Tree Farm, Warstock, Solihull, Birmingham, 14 (Nov. 26).

Worcs. Bordesley Lodge Farm, Redditch (Nov. 28).

Yorks. Piggeries, Thorpe Road, East Ardsley, Wakefield (Nov. 28).

CORRESPONDENCE

The views expressed in letters addressed to the Editor represent the personal opinions of the writer only and their publication does not imply endorsement by the B.V.A.

Conserving Petrol Supplies

Sir,—Many veterinary surgeons will be getting more petrol coupons than most road users when the rationing of the sale of petrol begins, in order that they may carry out their normal professional duties.

Might I, as President of the Royal College of Veterinary Surgeons, stress the need upon those who receive this extra ration not only to use the same with intelligent economy in the interest of the country but, in addition, to see that this privilege is not abused. The good name of the profession will depend on everyone playing fair. Unnecessary use of petrol would bring discredit to all of us and criticism from those who, by the need for this rationing measure, may often be severely inconvenienced in their daily life.

L. P. PUGH,
President.

The Royal College of Veterinary Surgeons,
9 and 10, Red Lion Square,
London, W.C.1.

November 28th, 1956.

Microphthalmia in Piglets

Sir,—The paper by Watt and Barlow on " Microphthalmia in piglets with Avitaminosis A as the probable cause " (*Vet. Rec.* **68**, 780) has performed a useful service in drawing attention to microphthalmia as a condition which is far from rare in

Great Britain to-day and which, in affected herds, may be of serious economic importance.

It is our impression that congenital microphthalmia in pigs has become more common of late; since October of last year we have received material from five outbreaks of microphthalmia, while the preceding three years offered only one outbreak.

The majority of these cases histologically resemble those described in the above paper, the commonly recurring lesions being the thinning of the posterior sclera, the formation of " pseudo-alveoli " by the nervous elements of the retina, and the abnormal presence of cartilage near to, or in the substance of, the lens. One outbreak was particularly interesting in that both microphthalmia and macrophthalmia were present, sometimes in the same piglet. In these cases the macrophthalmia appeared to be due to massive intraglobular haemorrhage.

Unfortunately, liver vitamin A values were not available in all cases, but in one outbreak a one-week-old piglet gave a result of 171 I.U. vitamin A per 100 grammes liver (information for which we are indebted to E. A. Gibson, Esq., Assistant Veterinary Investigation Officer, Cambridge), and in another outbreak a 12-week-old pig gave a result of 1,535 I.U. vitamin A per 100 grammes liver. The value of such estimations may be queried, since the critical deficiency is presumed to occur early in pregnancy (Hale, F., 1937. *Texas State J. Med.* **33.** 228), but we feel that they might be of considerable interest. While a " normal " level could well be ascribed to correction of the diet of the mother after the crucial period of pregnancy, an abnormally low level would be of some significance, particularly if no change of diet had been made.

It is unfortunate that in the outbreak they described, Watt and Barlow should have placed emphasis on " Avitaminosis A as the probable cause," since it appears that, in fact, no vitamin A estimations were made on affected piglets or their dams, and that a therapeutic experiment designed to test the hypothesis proved abortive.

There is little doubt from Hale's work that defective development of the eyes of piglets can be produced by hypovitaminosis A at the material stage of pregnancy, *i.e.* about 30 days of foetal life, but the circumstantial evidence quoted by Watt and Barlow does not seem to provide an unequivocal basis from which to draw such a deduction. For example, it seems curious that among the gilts in group II, the only one to have an unaffected litter was the last to farrow and had presumably been on the defective regimen longest before conception; the administration of vitamin A to this gilt on the 89th day of pregnancy is irrelevant if Hale's contention is correct.

Without wishing to read too much into the available evidence or to draw any firm conclusions as to the aetiology of the cases described, we feel that the facts given would also fit a hypothesis that the abnormalities seen were the product of subclinical maternal infection in early pregnancy, possibly transmitted at the time of first service. The fact that abnormalities were virtually confined to the litters of gilts might be explained on the grounds that mating offered their first exposure to the hypothetical infection. The inference that gilt B72 (the only one in group II to produce a normal litter) had not conceived to the first service after being put to the boar might be adduced as supporting evidence.

In the course of preliminary experiments at this laboratory on mild infections during pregnancy, a gilt was inoculated, on the 21st day after service, with an attenuated (lapinised) strain of swine fever virus and kept under constant conditions of diet and management. Though she at no time showed any signs of ill-health, her litter of 11 piglets included one with cleft palate, one with a shortened and deformed tail, one " jelly pig " of the type described by Young, Kitchell, Luedke & Sautter (1956) (*J.A.V.M.A.* **126.** 165), which also showed cyclopia with lateral compression and duplication of the upper jaw, one stillbirth and one piglet showing unilateral microphthalmia. This bouquet of abnormalities presents a picture not unlike that described by Hale (*op. cit.*) yet liver vitamin A levels of the three of the abnormal piglets, killed before suckling, were 1,130, 1,160, and 1,682 I.U. per 100 grammes. The last was the value for the microphthalmic piglet. All vitamin A estimations were carried out by the Biochemistry Department, Veterinary Laboratory, Weybridge.

Though this work is obviously very limited, it does suggest that microphthalmia and allied congenital abnormalities may possibly be caused by maternal viral infection during pregnancy even in the complete absence of signs of ill-health in the mother, and that all such abnormalities should not be ascribed to hypovitaminosis A without positive evidence that such a deficiency has occurred.

Yours faithfully,

J. D. J. HARDING,
J. T. DONE.

Ministry of Agriculture Veterinary Laboratory,
New Haw,
Weybridge, Surrey.

December 4th, 1956.

Content of "The Veterinary Record"

Sir,—I can sympathise with both Mr. Nye and Mr. Taylor, because I have had three articles and one letter in succession refused publication, and the excuse given by the Editor was so weak that I have thought of resigning. Why should a layman have the audacity to refuse a public letter, especially when he allows a non-member of the profession to write five articles on laboratory animals which are not of interest to the busy practitioner? Writing letters or articles is now similar to taking an examination—you wonder if they will *pass or not*.

No wonder many RECORDS are never opened but go direct into the waste-paper baskets. Everything and anything should be published which is sent in by a member of the Association, and the only scrutineer should be a solicitor in cases where some personality has been brought into the correspondence. If the articles are not instructive they may be amusing. They would certainly promote a better

feeling amongst the members than exists at the present time; and unless there is that brotherly feeling amongst the profession we shall receive fewer and fewer letters and articles.

The organisation is wrong. The editor ought to be a member of the profession and that would give prestige and status to the paper and encouragement to the writers. What right has a layman to refuse professional letters and articles? The editor should be supported by two part-time editors, also members of the profession, who should work in harmony with each other and attend meetings and conferences appertaining to the animal world. We had no one at the International Conference at Cambridge on Animal Reproduction, and in addition someone should have attended the annual meeting at Harrogate of the R.S.P.C.A. and given us a report of what took place there.

These two sub-editors should provide us with a digest of agricultural articles each week—a whole page so that it would be a pleasure to read the paper at one's siesta on a Sunday afternoon. The salaries alone were £6,236 last year which shows that there must be plenty of staff. Also, I assume that the scrutineers are not in practice but otherwise engaged, and that is the reason why ordinary articles are not allowed to be published.

Yours faithfully,

G. C. LANCASTER.

Eastwick House,
Evesham,
Worcs.

November 25th, 1956.

Anaesthesia and its Application in Small-animal Practice

Sir,—The point raised by Mr. R. A. Brown in his letter, interested me very much.

I would suggest that shock was a greater factor than physical exertion. I have read reports by American surgeons in the Pacific battle-area, where shock was the cause of the high mortality rate when general anaesthesia was administered.

All general anaesthetics given to shocked animals, in my opinion, entail a definite risk.

Yours faithfully,

G. L. B. HENDERSON.

30, Claremont Road,
Surbiton.

November 26th, 1956.

The Use of Dehorning Collodion in Calves

Sir,—It may interest your correspondent Mr. W. J. Jones-Davies to know that we encountered a condition in dehorned calves similar to that described in his letter.

In this case, however, disbudding of six Shorthorn calves was carried out at about three weeks old by means of cornual nerve block and the electric disbudding iron. One week later four of the calves were observed to be dull and appeared to be blind, although still taking milk. Temperatures were high, but the condition responded to treatment with sulphonamides and the calves returned to normal in about a week. At no time did the disbudding wound appear to be infected.

We are not sure if the condition can be ascribed to the dehorning, but at any event cannot be related to the use of collodion.

Yours faithfully,

D. J. BARTON.

1, Brook Street,
New Bedford Road,
Luton.

November 26th, 1956.

Refugee Veterinary Surgeons

Sir,—Amongst the tragic stream of Hungarian refugees now seeking sanctuary in our country it is possible that there are some members of our profession.

I am writing to suggest that the B.V.A. might make enquiries and, if this is so, make every effort to ensure that these veterinary refugees are enabled to follow their profession either amongst us in Britain or in the Commonwealth.

If it is a matter of funds, let us organise our own special collection to enable students to continue their studies or qualified men to do extra study for the M.R.C.V.S. The fund could be in memory of the great Professors Slutysa and Marek of Budapest—men to whom the veterinarians of the world are indebted.

Yours faithfully,

F. B. EDWARDS.

"Newgate,"
Llanbrynmair,
Mont.

November 24th, 1956.

DISEASES OF ANIMALS ACT, 1950—GREAT BRITAIN

Summary of Returns of Confirmed Outbreaks of Scheduled (Notifiable) Diseases

Period		Anthrax	Atrophic Rhinitis	Foot-and-Mouth	Fowl Pest	Sheep Scab	Swine Fever
1st to 15th November, 1956		14	—	7	70	—	17
Corresponding period in	1955	57	—	—	49	—	50
	1954	23	—	—	29	—	49
	1953	17	—	5	35	—	73
1st January to 15th November, 1956		1,197	11	135	673	—	667
Corresponding period in	1955	687	6	6	514	—	1,274
	1954	280	4	12	659	—	1,294
	1953	545	—	34	825	—	2,509

ATTESTED HERDS

AREA ERADICATION PLAN FOR TUBERCULOSIS STATEMENT OF POSITION AT SEPTEMBER 30TH, 1956

COUNTRY	Total cattle on June 4th, 1956 (Provisional figures) ('000)	Estimated per cent. of Attested Cattle	Number of herds on the Attested Herds Register
GREAT BRITAIN	9,993	67	163,351
ENGLAND AND WALES	8,257	64	124,917
ENGLAND	7,202	60	89,775
WALES	1,055	85	35,142
SCOTLAND	1,736	84	38,434

COUNTY SUMMARY

I.—Counties within Attested Areas (it is assumed that, for all practical purposes, 100 per cent. of the cattle in these counties are attested).

	Total cattle on June, 4th 1956 (Provisional figures) ('000)	Number of herds on the Attested Herds Register
ENGLAND		
Cumberland	251	4,952
Westmorland	104	2,182
Isles of Scilly	0·7	86
WALES		
Brecon	53	1,874
Cardigan	88	3,962
Carmarthen	150	6,099
Merioneth	41	1,737
Montgomery	108	3,905
Pembroke	120	3,716
Radnor	43	1,521
SCOTLAND		
Argyll	66	2,236
Ayr	165	2,301
Bute	12	325
Clackmannan	5	82
Dumfries	117	1,980
Dunbarton	19	344
Fife	73	1,081
Kinross	11	183
Kirkudbright	83	1,108
Lanark	102	1,760
Midlothian	26	536
Peebles	14	289
Renfrew	33	532
Selkirk	8	221
Stirling	47	872
West Lothian	18	344
Wigtown	82	902
Zetland	7	1,549

II.—Counties where the percentage of attested cattle is estimated to be between 75 and 99

	Total cattle on June, 4th 1956 (Provisional figures) ('000)	Number of herds on the Attested Herds Register
ENGLAND		
Berks*	96	1,416
Essex	130	1,650
Hereford	157	2,848
Southampton*	166	3,090
Isle of Wight*	24	565
Surrey*	60	1,196
Sussex West*	84	1,210
WALES		
Caernarvon*	65	3,040
SCOTLAND		
Caithness*	28	1,198
E. Lothiam†	16	253
Inverness*	54	4,470
Nairn*	10	185
Orkney*	50	1,985
Ross-shire*	43	4,337
Roxburgh†	39	653
Sutherland*	10	1,104

III.—Counties where the percentage of attested cattle is estimated to be between 65 and 74

	Total cattle on June, 4th 1956 (Provisional figures) ('000)	Number of herds on the Attested Herds Register
ENGLAND		
Bucks*	123	1,235
Devon†	436	7,540
ENGLAND (*contd.*)		
Dorset†	177	2,308
Gloucester	214	2,599
Hertford	65	689
Oxford*	119	1,376
Somerset†	345	5,196
Suffolk East	90	1,266
Wiltshire†	232	2,410
WALES		
Anglesey*	62	2,073
Denbigh*	110	3,066
WALES (*contd.*)		
Monmouth*	74	1,443
SCOTLAND		
Berwick†	36	397
Moray†*	34	562
Perth†	101	1,828

*Counties or parts of counties where free-testing facilities have been available since March 1st, 1955.

†Counties or parts of counties where free-testing facilities have been available since March 1st, 1956.

IV.—Counties where the percentage of attested cattle is estimated to be between 55 and 64

	Total cattle on June, 4th 1956 (Provisional figures) ('000)	Number of herds on the Attested Herds Register
ENGLAND		
Durham	127	1,946
Huntingdon	31	194
Kent†	131	1,697
Lancashire	283	4,899
Soke of Peterboro'	7	46
Shropshire	308	3,473
Suffolk West	43	425
Sussex East†	117	1,507
Yorks,* West Riding	353	5,530
WALES		
Flint	63	981
SCOTLAND		
Angus	71	550

V.—Counties where the percentage of attested cattle is estimated to be between 45 and 54

	Total cattle on June, 4th 1956 (Provisional figures) ('000)	Number of herds on the Attested Herds Register
ENGLAND		
Cambridge	40	233
Cheshire	249	2,902
Cornwall	292	4,442
Derby	190	1,758
Middlesex	8	84
Norfolk	205	1,511
Northampton	152	940
Warwicks	153	1,310
Worcester	111	993
Yorks,* North Riding	275	4,245
WALES		
Glamorgan	78	1,725
SCOTLAND		
Aberdeen	249	3,081
Banff†	63	826
Kincardine	45	360

VI.—Counties where the percentage of attested cattle is estimated to be less than 45.

	Total cattle on June, 4th 1956 (Provisional figures) ('000)	Number of herds on the Attested Herds Register
ENGLAND		
Bedford	49	356
Isle of Ely	22	74
Leicester	171	1,146
Lincoln, Parts of Holland	29	63
Kesteven	73	427
Lindsey	166	916
Northumberland	215	1,459
Nottingham	115	915
Rutland	22	77
Stafford	243	2,016
Yorks, East Riding	148	637

THERE WERE ALSO 2,788 SUPERVISED HERDS. THESE HERDS NEED ONLY ONE CLEAR TUBERCULIN TEST TO QUALIFY AS ATTESTED HERDS.

Johne's Disease

T. M. DOYLE

Veterinary Laboratory, Weybridge

JOHNE'S disease is an important disease of cattle in many parts of the world and it would appear to be causing increasing economic loss. Considerable information on its prevalence in Britain has been obtained from a survey started in 1946 by the Veterinary Laboratory, Weybridge, with the co-operation of the Veterinary Investigation Officers; through the Ministry's vaccination scheme; from the cultural examination of lymph glands of apparently normal cattle by Taylor (1949 and 1952), Rankin (1954) and Smith (1954); and from information obtained from veterinary surgeons, stock-owners, and knackermen. The survey is limited to the recognition of clinical cases, diagnosis being based on the examination of faecal smears from suspected animals; but this method misses many infected animals and in addition fails to detect cases of latent infection. Only a relatively small percentage of infected animals develop clinical symptoms, but many bred in infected herds contract infection and become either temporary of permanent carriers of *M. johnei;* some of these lose condition, milk poorly and are finally culled from the herd; and many are either potential or active spreaders of infection and add to the difficulties of control.

The disease, being an insidious infection, does not give rise to sudden spectacular losses, but year by year it exacts a heavy toll and is responsible for much greater losses than most other infections. The annual herd mortality varies between 2 and 10 per cent.; but in badly infected herds it may occasionally rise as high as 25 per cent. In estimating loss it should be remembered that animals disposed of because of other major diseases (*e.g.* contagious bovine abortion, mastitis, sterility) usually have a considerable carcase value, but the Johne's animal brings only a knacker's price. Farmers everywhere enshroud the disease with a veil of secrecy that makes it difficult to ascertain its true prevalence or to suggest even a rough estimate of the financial loss, but that this is substantial in most infected countries cannot be doubted. To obtain some idea of its prevalence and distribution, as is being done in Britain, it is essential to make a survey of a representative number of herds of the various breeds of cattle in different areas. Without such information for each country the size and importance of the problem must remain unknown.

Distribution and Prevalence

Johne's disease is world-wide in its distribution. It is particularly prevalent under temperate climates and especially in areas of intensive dairy farming; it occurs also in wet, humid areas of the tropics, but is apparently unable to gain a foot-hold where the climate is hot and dry.

There is little accurate information on its distribution and prevalence before 1939 in Britain, but many people, both professional and laymen, who are in close contact with the dairy industry believe that it has greatly increased during the last 10 to 15 years. M'Fadyean (1907) stated it was of comparatively common occurrence in Great Britain. Twort & Ingram (1913) estimated the yearly loss caused by it among dairy cattle to be at least £500,000; this sum did not include losses in beef herds or among sheep, or the extra value of pedigree stock. Gaiger (1932) mentioned its high incidence in Lancashire and Cheshire; and Dunkin (1934) referred to the huge financial loss caused by it in England and considered that it was in certain areas the most important disease of cattle. Gofton (1934) examined the intestines of 297 cows at Gorgie abattoir and found that 57 were thickened and corrugated. Microscopical examination revealed acid-fast bacilli, morphologically indistinguishable from *M. johnei,* in 21 (7 per cent.). Clinical symptoms were present in one only of the 57 cows which showed lesions of the disease. Taylor (1949) cultured the ileo-caecal lymph glands of 243 apparently normal cattle at an abattoir and isolated *M. johnei* from 37 (15 per cent.). The same author (1952) examined a further 665 cattle and isolated *M. johnei* from 101 (15 per cent.). Rankin (1954) recovered *M. johnei* from 6.0 per cent. and 7.5 per cent. of apparently normal cattle; the corresponding figure for 256 imported Irish cattle (the disease is relatively rare in Ireland) was 0.8 per cent. Smith (1954) isolated *M. johnei* from the lymph nodes of 51 out of 300 (17 per cent.) apparently normal cattle. This high incidence of latent infection is similar to that in the other major bacterial diseases of cattle (tuberculosis, contagious abortion, chronic streptococcus mastitis) which occur in Britain. Doyle & Spears (1951) examined microscopically 3,815 faecal samples from suspected animals from 30 counties and 976 were positive (25 per cent.).

Soltys (1951) examined 988 faecal samples mainly from the north-west counties and Midlands and 328 were positive (33 per cent.). Rinjard (1934) stated that in France the disease had spread in 20 years from two to 41 Departments. In one Department there was an annual mortality of about 24,500 cattle out of a total of 305,000 (8 per cent.). Houthuis (1932) believed it was increasing in some areas of Holland where there was an annual loss of 12 to 15 per cent. Jansen (1948) reported that a survey carried out by Sjollema showed that parts of the province of Friesland, the Netherlands, were heavily infected. Williams (1927) estimated the losses in infected herds in America at from 2 to 12 per cent. in addition to the indirect losses represented by decreased milk production and general unthriftiness.

Moore (1924) compared the position of the disease in America with that of bovine tuberculosis 60 years earlier and prophesied that failing effective control,

it might become a greater scourge for future generations than tuberculosis had been for those past. Hagan & Zeissig (1935) mentioned that Johne's disease was slowly but surely spreading among American cattle. It is stated in the American Goverment Yearbook of Agriculture (1942) that veterinarians and live-stock officers believe the disease is spreading, and failing control measures it will become as serious a menace as in Europe. According to Larsen (1951) the annual death-rate in infected herds in America might be as high as 10 per cent. of adult stock; but the average annual loss was about 3 per cent. Little effort was made to control it and pedigree animals sold for breeding were gradually disseminating the infection. Dimock (1952) believed the disease was already widespread in the United States. Albiston & Talbot (1936) stated that the first reported case in Australia occurred in 1925 in Victoria; the evidence suggested that it was introduced either by a local bull or by a bull imported in 1915 from England. It spread from the original herd through a series of 10 new herds, by the sale of preclinically infected animals. Albiston (1950) reported that there were about 41 known infected herds in Victoria. Prewett (1950) believed it to be endemic in Victoria, but apparently only a relatively small number of herds were infected and the annual mortality was about 2.7 per cent. MacIndoe (1950) mentioned its presence in South Australia and in Tasmania; it was probably introduced into South Australia from Victoria. Chandler (1955) stated that the disease is becoming of increasing importance in New Zealand. In 1946 compensation was paid for 94 clinical cases; in 1950 the numbers had risen to 303. Stephens (1955) regarded the disease as the major cause of wastage among cattle in Taranaki, responsible for greater losses than tuberculosis. He diagnosed it on 360 farms in this area alone, but considered the actual number infected was considerably higher. In Kenya the disease has recently shown an alarming increase, particularly among Channel Island breeds, and the imposition of quarantine restrictions is under consideration. Its incidence is increasing in British Columbia and it is believed that if control measures are not taken it will become a serious menace. In addition to the countries mentioned the disease is widespread throughout Europe and it has been reported from North, South and West Africa, India, Iceland, Ireland and South America. The disease is scheduled in Canada and Eire; a voluntary notification scheme, combined with compensation, is operated in Northern Ireland. Lovell, Levi & Francis (1944) found that *M. johnei* survived for 246 days in naturally infected faeces in a shallow bowl exposed to the effect of sunshine and rain. It is conceivable that under favourable field conditions the organisms could survive longer. Posokhin (1954) reported that bovine and avian tubercle bacilli survived for two years on artificially infected ground in Western Siberia. In view of the considerable resistance of the bacilli to climatic conditions, the vast number that are excreted with the faeces of affected animals and the general neglect of elementary hygienic precautions, it would be surprising if the disease did not spread.

It will be seen from this brief survey that the disease is now an international problem of great economic importance and urgency; and the evidence shows that it is gradually being introduced to new areas. Yet few countries evince much apparent interest either in its control or investigation, they appear resigned to a policy of *laissez-faire*. This attitude is no doubt influenced by the high incidence of the infection and the technical difficulties inherent in its investigation, but it is a short-sighted policy.

Methods of Diagnosis

The symptoms have considerable diagnostic value, as at least in European countries the great majority of cases of chronic diarrhoea in adult cattle are caused by Johne's disease. There is little difficulty in distinguishing between it and tuberculosis enteritis by clinical symptoms, because when diarrhoea is present in cases of tuberculosis there is usually evidence of disease affecting the lungs. The symptoms of hypocuprosis are similar to those of Johne's disease, but the condition is usually most severe in young growing animals; when first calf heifers are severely affected it is difficult to distinguish between the two conditions by clinical examination.

Microscopical examination of Faecal Smears

The microscopical examination of faecal smears, though an essentially crude test, is of considerable value in differential diagnosis. It is also the only rapid method by which a positive diagnosis can be made with certainty in the living animal. Johne's bacilli can with experience be readily distinguished morphologically from the saprophytic acid-fast bacilli found in faeces. The best time for examination would appear to be when diarrhoea is present, as abnormal shedding of the superficial layers of the intestinal mucosa then occurs and the bacilli may be excreted in sufficient numbers to be detected in smears. The finding of groups of typical acid-alcohol-fast bacilli puts the diagnosis beyond doubt; but only 25 to 30 per cent. of positive cases can be diagnosed at the first examination of smears. When persistent watery diarrhoea is present, it may be necessary to make repeated examinations before the bacilli can be found. The microscopical examination of a pinched-off shred of rectal mucosa is of value only in advanced cases. The examination of smears from apparently normal animals in infected herds for the detection of early cases would appear to be of little value. Microscopical examination of faecal smears should be restricted to confirming the disease in clinically affected animals, and at that stage the symptoms are usually sufficiently characteristic for diagnosis.

Allergic Tests

Much work has been carried out on the diagnostic value of "johnin" and of avian tuberculin. There is apparently little to choose as regards efficiency between the two products, but johnin, because of its origin, is more generally used. Hagan & Zeissig

(1933) used either johnin or avian tuberculin intravenously and based diagnosis on temperature reaction.

Both products have been used subcutaneously, intravenously and intradermally, but it is here proposed to deal only with the intradermal route, as the other methods are less reliable and are more laborious and time-consuming. Although johnin has been available for the past 40 years, it is significant that it has failed to find a place in practice. It has been submitted to many trials under both experimental and field conditions and results have not been consistent. It is essential in testing the product if the results are to be of value, that *post-mortem* examination should be made of experimental animals and smears of intestinal mucosa and lymphatic glands examined microscopically and where these are negative appropriate tissues cultured. There is considerable difference in degree between the allergy induced by artificial infection and that by natural infection. Good allergic reactions are the rule following artificial infection but in natural infection the reactions vary from moderate to poor and inconclusive and animals in an advanced stage of the disease rarely react. Johnin reactions are usually smaller and more fleeting than those induced by tuberculin in tuberculosis and the product is much less efficient than tuberculin. Different methods of preparing johnin have been tried, some products were undoubtedly of low potency, but others made in accordance with modern technique (*e.g.* P.P.D.) have also proved unreliable. M'Fadyean, Sheather and Edwards (1916) showed that johnin was not specific and could evoke reactions in animals artifically infected with bovine, human or avian tubercle bacilli. Dunkin (1928) tested 40 clinical cases and only a few failed to react; *post-mortem* examination confirmed the diagnosis. Houthuis (1932) considered the intradermal test to be of value provided a potent johnin was used. Rinjard (1934) stated that johnin fails to elicit reactions in 80 per cent. of clinical cases.

Broerman & Fogle (1932) conducted *post mortems* upon 19 reactor cattle; 12 were positive and seven negative on microscopical examination. Three negative animals were found to be infected. Minett (1933) carried out a double intradermal test on 499 cattle in seven herds. Counting positive and doubtful reactors the average incidence in these herds was 28 per cent., with extremes of 7 and 56 per cent. The same worker (1935) tested 59 cattle and 53 gave positive reactions; and 52 of these were submitted to *post-mortem* examination. Thirty-nine were infected and it was claimed that there was presumptive evidence of infection in 11 of the remaining 13; six infected animals did not react to johnin, but four of these were at an advanced clinical stage. Tuberculous lesions were present in eight of the 39 reactors. McEwen (1939) reported irregular test results on both artifically and naturally infected cattle. An Agricultural Research Council Committee (1941) tested cattle at an abattoir. *Post-mortem* examinations were made on 103 animals; these animals could hardly be regarded as suitable for assessing the product as 30 were infected with tuberculosis and 11 had dual infections of tuberculosis and Johne's disease. Considerable discrepancies were found between reactors and non-reactors and the results of *post-mortem* examinations—which included histological examinations and culture of tissues. Two preparations of johnin were used and there was sufficient agreement between them to suggest that they were not responsible for the discrepancies in the results.

Johnson, Milligan & Cox (1941) tested 347 cattle with both johnin and mammalian tuberculin. Twenty-four reacted to johnin and nine of these were positive also to tuberculin. None of the 313 johnin negative cattle reacted to tuberculin. No lesions of tuberculosis were found in the nine animals that reacted to both tests but all had lesions of Johne's disease and *M. johnei* was isolated from eight of them.

According to Jansen (1948) about 33 per cent. of infected animals fail to react to johnin. Albiston & Talbot (1936) made 1,150 double intradermal tests and obtained 15 positive reactions, but the disease could not be confirmed at autopsy either by microscopical or cultural examination. MacIndoe (1950) considered the intradermal test to be of limited value and left much to be desired. Prewett (1950) reported that 36 reactor cattle were submitted to bacteriological examination and the disease was confirmed in only 10. Sikes (1953) made a series of tests at intervals of 14, 16, 18 and 20 weeks on eight naturally infected Jersey cows. He observed that reactions occurred in a previously unused site, whereas repeated tests in the same site were negative. He considered the intradermal johnin test to be a highly efficient diagnostic method.

In an investigation carried out by the World Health Organisation (1955) on repeated tuberculin tests in the same site, it was found that in allergic persons reactions to tuberculin injected in the site of a previous test developed differently from reactions obtained in unused sites. The used-site reaction appeared sooner, attained a greater maximum size, presented a much higher frequency of bullae and faded sooner.

To sum up, it would appear that the johnin test frequently fails to induce reactions in preclinical cases of infection; and there is the serious, but perhaps lesser objection that it may induce reactions in animals sensitised by avian or by mammalian tubercle bacilli. It fails also to elicit reactions in the majority of clinically affected animals, but this is not of great importance as the symptoms exhibited are usually characteristic and other diagnostic methods are available at this stage. There appears to be a considerable lag between the occurrence of natural infection and the onset of sensitisation. Animals that have been infected for some time either with Johne's bacilli or with avian tubercle bacilli may give a fair reaction to the first test, but a second test made within a period of three months or even longer is generally either negative or of an indefinite character. The first test appears to exhaust the small amount of sensitising factor present in the system. The

repeated testing of heavily infected herds rarely, if ever, eradicates the disease. The early hopes that johnin would detect a high proportion of preclinical cases have not materialised and the results have, in general, been disappointing. The evidence points clearly to the low allergic state of the naturally infected animal and not to johnin of low potency as the main cause of failure.

Period of Incubation

The period of incubation varies widely in different animals depending perhaps on individual susceptibility, breed, nutritional plane and the degree of infection to which the animal has been exposed. It is rarely less than 12 months and may extend to many years. Infected animals may remain apparently normal for years before developing symptoms, and it is probable that some infected animals never show symptoms. The peak period of clinical infection lies between the second and fifth year of age and symptoms most frequently occur within a few weeks of calving. The clinically affected animal may live for a few weeks or for many months.

Susceptibility in Relation to Age

The effect of age upon susceptibility to the disease is of considerable practical importance as it is closely related to possible methods of control. By age susceptibility is here understood the period during which an animal can contract infection and subsequently develop clinical disease. The work of Meyer (1913) and M'Fadyean & Sheather (1916) suggested that the young animal is most susceptible. Hagan (1938) reported that in a heavily infected, experimental herd maintained under bad conditions of diet and hygiene, no animal exposed to natural infection contracted the disease after four months of age. There was also a marked resistance to artificial infection in animals over two years of age as none developed clinical disease when given large doses of infected natural material *per os*. It is, however, essential in this type of work that experimental animals be obtained from a Johne's disease-free area. The resistance of adult animals to other diseases is chiefly the result of exposure to infection during early life; so experiments on animals bred in an infected area may give false results. It would appear, from field experience in this country, that calves separated from their dams at birth and isolated during the first 8 to 10 months of life in houses can later develop clinical disease. Houthuis (1932) observed the disease mainly in animals from two-and-a-half to four years of age, but he also found animals from 6 to 14 years of age clinically affected. Doyle & Spears (1951) analysed the age incidence of 648 clinical cases and found the peak of infection lay between the second and fifth year. Forty-one cases occurred between the 7th and 13th year; it is impossible to determine when these animals became infected, they may have contracted the disease during early life and remained carriers until some adverse condition reactivated it or they may have picked up infection during adult life. It is probable that some adults contract infection and either recover or become permanent, symptomless carriers or develop clinical disease. Buddle (1949) believes that there is ample field evidence that adult animals may acquire infection under conditions of heavy exposure and die of the disease, but that spread of infection is facilitated by the presence of the highly susceptible young animal.

Doyle (1953) gave infected natural material *per os* to 12 susceptible Irish cattle, varying in age from 17 months to six years; and two steers aged 17 months and two years, and two cows, aged between five and six years, developed clinical disease.

To sum up, it would appear from experimental and field evidence that infection occurs during a variable period of early life and to a lesser extent when animals are brought in contact with the disease for the first time as adults. To this must now be added congenital infection of the progeny of clinically affected cows.

Foetal Infection

Alexejeff-Goloff (1929) was the first to report the isolation of Johne's bacilli from the foetus of a clinically affected cow. Hole (1953) found acid-fast bacilli, indistinguishable morphologically from *M. johnei*, in the cotyledons of an affected cow. Lawrence (1955) cultured 16 bovine foetuses, 11 were from clinically affected cows, and five from apparently healthy cows. From the foetuses of five of the affected cows acid-fast bacilli were isolated from the liver, spleen and kidney and small intestine, but were not obtained from the cotyledons of any pregnant cow; three non-pregnant uteri contained a considerable number of acid-fast bacilli.

Doyle (1955) confirmed Lawrence's results. He cultured 22 foetuses from clinically affected cows, and isolated acid-fast bacilli from the cotyledons (seven), spleen (three) and liver (two). Guinea-pigs inoculated subcutaneously and rabbits intravenously with culture suspensions of the bacilli remained normal and no lesions were present on *post-mortem* examination. Pearson & McClelland (1955) isolated acid-fast bacilli from the ileo-caecal lymph node and intestinal mucosa of an eight-month-old foetus and from the uterus of a clinically affected cow. From a second affected cow acid-fast bacilli were isolated from the uterine mucosa.

As the acid-fast bacilli isolated from all these cases were morphologically and culturally indistinguishable from *M. johnei* and as the foetuses were from clinically affected cows, there is strong presumptive evidence that the bacilli were in fact *M. johnei*.

Alexejeff Goloff (1929) isolated Johne's bacilli from the milk of three clinically affected cows. The bacilli were observed microscopically on *post-mortem* examination in the udder tissue and supramammary lymphatic glands.

Doyle (1954) examined microscopically and culturally the udder tissue of 34 clinically affected cows; the microscopic examinations were negative, but *M. johnei* were isolated from two udders. He considered the excretion of Johne's bacilli in the milk of

clinically affected cows to be relatively rare and probably occurs only in the fulminating type of infection.

Cross protection among the Pathogenic Acid-fast Bacilli

It has long been known that varying degrees of cross-protection occur among the members of the pathogenic acid-fast group of organisms. Von Behring (1902) reported that strains of human tubercle bacilli afforded considerable protection against bovine strains. M'Fadyean and his co-workers (1913) found that avian tubercle bacilli conferred a considerably increased resistance to calves against bovine strains. M'Fadyean & Sheather (1916) believed that tubercle bacilli (both human and bovine strains) conferred some protection against Johne's disease, but that the number of animals they used was too small to justify a definite conclusion. Wells & Brooks (1940) showed that the vole acid-fast bacillus conferred strong protection to guinea-pigs against subsequent tuberculous infection. BCG vaccine, consisting of a living, avirulent bovine strain, confers considerable protection against both human and bovine tubercle bacilli. Doyle (1953) showed that Johne's vaccine afforded an appreciable degree of protection to goats against artificial infection with bovine tubercle bacilli. The tuberculous lesions in vaccinated goats examined at five, eight and 11 months after the infective dose of tubercle bacilli, were considerably less than in controls; but the lesions present after 20 months were as extensive as in controls.

It is of interest to note that there is evidence that tubercle bacilli may confer some protection against leprosy (caused by an acid-fast bacillus—*B. leprae*). Chaussinand (1948) considered that anti-leprosy immunity may result from either leprosy or tuberculosis because of the similarity of the two antigens.

According to Floch & Destombes (1949) the inhabitants of areas in which tuberculosis is endemic show a certain degree of resistance to leprosy, but that leprosy does not provoke any resistance to tuberculosis. Rosenberg, Campas & Aun (1950) in a report on the immunological relationship between tuberculosis and leprosy stated that BCG vaccine confers some protection against leprosy. Francis (1947) commenting on the effect of tuberculous milk on the epidemiology of human tuberculosis, stated that in country districts in Britain there is an inverse relation between the incidence of bovine tuberculosis and the total mortality from human tuberculosis. In Denmark though the proportion of tuberculin-positive persons is greater in areas where tubercle bacilli occur in the milk, tuberculous disease is less common there than in areas where the milk is free from bacilli. He believed that as milk is freed from tubercle bacilli by the eradication of tuberculosis and by pasteurisation, more will have to be done to protect adolescents from infection and increase their resistance by immunisation with BCG.

It would appear that there is at least one antigen common to pathogenic acid-fast bacilli and that it is responsible for a variable degree of group protection. The presence of this antigen has long been recognised by the cross-reactions that occur in serological and allergic tests within this group of organisms.

The rapid progress that is being made in many countries in the eradication of bovine tuberculosis may possibly have a reaction on the epidemiology of Johne's disease. It is not yet proved that the elimination of tuberculosis from a herd favours the spread of Johne's disease, but the evidence suggests that probability and if this proves to be correct, it will aggravate the present serious situation.

Control of the Disease

The disease is usually introduced into a herd by a preclinically infected animal which subsequently develops symptoms. It is spread within a herd by infective faeces contaminating pastures, water or foodstuffs; some calves are born infected and many contract infection from milk contaminated with faeces. Whether or not an infected animal develops symptoms would appear to depend on one or more of a number of factors, *e.g.* calving, low nutritional plane, heavy milk yield, fluke infestation, grazing on wet low-lying land, or on mineral deficient land etc., in fact on any condition that may lower bodily resistance and activate a latent infection. There is no evidence that there is one predisposing factor common to all infected herds.

Smythe (1935) observed that on the Cornish coast where the soil contains up to 25 per cent. of calcium carbonate from the fine, blown shell sand, clinical disease is rare, although typical lesions are frequently found on *post-mortem* examination. But when cows from this area are moved to an adjoining region where the soil is acid and deficient in lime, they frequently develop clinical disease within a few weeks. According to French observers (1935) the soil is an important epidemiological factor mainly through excessive humidity and acidity. Wet soils and those deficient in phosphoric acid and calcium carbonate are believed to favour the persistence of infection. Jansen (1948) observed that in infected regions of the Netherlands the soil was deficient in calcium and had a low *p*H reaction. In less infected areas both the percentage of calcium and the *p*H were higher; and in free areas the percentage of calcium was higher still. On the north-west coast of Friesland where the soil is mainly sandy and there are many cattle, there is a much lower incidence of the disease than in wet areas of the province.

Nutrition and Management

The importance of nutrition in the control and treatment of human tuberculosis is established, and nutrition also plays an important part in the control of Johne's disease. It seems to be relatively difficult to set up clinical disease experimentally in an animal maintained on an adequate diet. It is easy to do so in an under-nourished animal. There is good reason to believe that the same is true under field conditions. In many herds young stock—during the age of greatest susceptibility to Johne's disease—are under-nourished particularly during the winter; and this is often obvious from their general appearance. To

undernourish the growing animal is a bad policy; growth is stunted and the defences of the body against disease are weakened. Yet it is a common practice. The poorly nourished animal falls an easy victim to many infections and particularly to Johne's disease. Moreover what may be a sound farming practice with a healthy herd may well be a bad practice with an infected herd; an example is strip-grazing. A herd infected with Johne's disease should not be strip-grazed because this system concentrates infective faeces on a relatively small area and provides greater opportunity for an animal to pick up infection.

Every calf in an infected herd should be removed immediately after birth from contact with its dam and bucket-fed.

Any cow affected either with intermittent or continuous diarrhoea, without obvious cause, should be isolated and be examined by a veterinary surgeon. Water troughs should be cleaned out weekly, because they are often polluted with faeces and may become dangerous reservoirs of infection. Ponds should be fenced. Drainage from cow-sheds should not be allowed to run on to pastures. Manure from an infected herd should not be put on pasture. Special care should be taken to prevent the contamination of buckets used for feeding calves.

It cannot be contended that good nutrition and good management will by themselves eliminate the disease from a herd. They will not. But an adequate diet especially during early life, and careful management, will lessen the degree of infection and reduce the number of animals which develop clinical disease.

Vaccination

Vallee (1924) carried out immunity experiments on cattle against tuberculosis, using an attenuated strain of tubercle bacillus of equine origin. He found that bacilli in a readily-absorbable excipient were eliminated from the system within three months and only a transient protection resulted. But when an unabsorbable excipient was used, a fibro-caseous nodule formed at the site of inoculation in which the bacilli persisted for two to three years, and a durable immunity was conferred. It is this procedure that Vallee successfully applied against Johne's disease.

The principle involved (premunition) is comparable to Koch's phenomenon—that it is not possible to superimpose infection in a sensitised animal; therefore by vaccinating and creating a state of sensitivity, the animal is protected against re-infection so long as sensitivity persists.

Twort & Ingram (1913) and M'Fadyean & Sheather (1916) failed to set up the disease by subcutaneous inoculation of Johne's bacilli. But it was Vallee & Rinjard (1926) who appreciated the importance of this fact. They stated: "We are surprised that a result, which appears so interesting from many points of view, as the innocuity of subcutaneous inoculation of Johne's bacilli, should not have attracted more attention from investigators. It is this fact that we have re-examined, developed and exploited."

The vaccine consists of unattenuated, living Johne's bacilli suspended in equal parts of liquid paraffin and olive oil, to which some powdered pumice stone is added. Five to 15 mg. of moist-dried culture, suspended in 1.75 ml. of the paraffin-olive oil mixture are injected subcutaneously in the dewlap or on the side of the neck. A small inflammatory swelling develops which is gradually replaced by a cold, non-painful, fibro-caseous nodule that persists from six months to two years or longer. The duration of immunity is not known, and is difficult to ascertain because of the gradually developing age resistance, but it would appear to be sufficient to protect a high proportion of animals during the period of greatest susceptibility.

Vallee & Rinjard (1934) reported that more than 35,000 cattle had been vaccinated without a single adverse incident. The vaccine proved effective on 133 heavily infected herds and partially effective on 20 herds. They claimed that vaccination of a preclinically infected animal does not produce a nodule even when it is repeated two or three times at intervals of six weeks; the inflammatory reaction that follows vaccination clears up and the vaccine is either absorbed or ejected by abscess formation. They regarded the inability to form a nodule as a reliable indication of infection. Vallee (1924) stated that the bacilli persisted for two to three years in the vaccinal nodule. The persistence of bacilli in the nodule would appear to vary widely with individual animals and may apparently be for any period between 15 and 30 months. We have been unable to find bacilli in the nodules of three out of four cattle examined after two years and eight months; in the fourth animal numerous degenerate acid-fast bacilli were found. Similarly the bacilli were not found in the nodules of five goats examined after two years and seven months; after 12, 14 and 15 months numerous acid-fast bacilli were still present in the nodule. It is not safe, therefore, to postulate that as long as the nodule persists revaccination is unnecessary; the nodule frequently persists long after the bacilli have been eliminated.

Doyle (1945) confirmed the safety of the vaccine by inoculating five calves subcutaneously with 30 mg. (six times the usual prophylactic dose) of unattenuated, living Johne's bacilli suspended in paraffin. Four of the five animals were killed two years and eight months after inoculation; they were in excellent condition and there was no evidence of infection on *post-mortem* examination. The fifth animal calved twice, passed through two lactations, and on *post-mortem* examination no infection was found. In addition, 18 goats were given 30 mg. of vaccine subcutaneously and kept under observation for two-and-a-half years; all remained in normal health and no infection was found on *post-mortem* examination. There is now a mass of field evidence confirming that the subcutaneous inoculation of certain strains of living Johne's bacilli are incapable of setting up the disease. It would be going too far to claim on the data available that no strain of *M. johnei* could set up infection on subcutaneous inoculation, but that claim can be made for the strains in use for the preparation of vaccine.

Vallee, Rinjard & Vallee (1941) reported that with further experience of the vaccine they were of the opinion that immunity persists even after the disappearance of the nodule; apparently they overlooked the influence of age resistance. If a sensitised animal is re-vaccinated, the second injection may cause abscess formation and, on the other hand, if re-vaccination is left too late, the animal will remain for a variable period unprotected. It is impossible to determine the optimum time for re-vaccination. Theoretically, it should be when sensitivity is waning or when the vaccinal nodule is regressing.

It is frequently assumed that tuberculin sensitivity is closely related to the resistance conferred by vaccination—there is no general agreement on this point—and as sensitivity wanes, resistance wanes with it.

Lominet (1936) in France stated that the vaccine is, in the opinion of veterinary surgeons and stock breeders, the best means of protecting cattle against Johne's disease. In Britain the vaccine has been under trial since 1946 in selected, infected herds scattered over England, Scotland and Wales. Its use has been restricted to calves under 30 days of age; older cattle in infected herds might have contracted natural infection before vaccination and clinical disease occurring in such animals, if they were vaccinated, would tend to confuse the results and bring the vaccine into disrepute. Animals in some herds received only one dose of vaccine; in other herds vaccination has been carried out two to four times, at intervals varying from 16 to 24 months. The vaccine is being judged on the comparative incidence of the disease in a herd *before* and *after* vaccination; the assessment being made not less than seven years after vaccination; *i.e.* when the vaccinated animals will have passed through the peak period of natural infection. This procedure is open to criticism, but its faults are reduced by the number of herds used, and it is believed that it will permit of a sound valuation under the varying conditions of diet, hygiene, etc., that occur in the field. In the majority of the herds little attention has been paid to the state of the vaccinal nodule, and in many instances re-vaccination was requested only when the disease occurred in an animal vaccinated three or four years previously. Yet the results obtained have been excellent and confirm those reported by Vallee & Rinjard.

Rinjard (1934) claimed that he had never seen a vaccinated animal, with acid-fast bacilli present in the nodule, exhibit symptoms. Therefore, in examining vaccinated animals which develop the disease attention should be paid to the interval that has elapsed since last vaccination and to the "activity" of the nodule. The only cases which can reasonably be regarded as "breakdowns" are those in which an animal exhibits clinical symptoms and has a persistent nodule containing acid-fast bacilli.

It would appear, from the evidence now available, that Johne's disease can be gradually eliminated from a herd by vaccination. Unfortunately, the close relationship between *M. johnei* and the bovine tubercle bacillus creates an obstacle to this procedure in countries engaged in the eradication of tuberculosis by tuberculin testing. The vaccine sensitises animals to tuberculin; and tuberculosis, because of its hazard to human health, must be given priority. So the problem is whether vaccination can be carried out in tuberculosis-free herds without interfering unduly with routine tuberculin tests; the use of vaccine on herds in the process of eradicating tuberculosis is out of the question. Herds free from tuberculosis usually comprise the most valuable in the country, but their freedom may well increase their vulnerability to Johne's disease.

It would appear, in the inadequate state of our knowledge of the disease, that some risk must be taken if the heavy losses are to be reduced, but whether the potential risk involved in vaccination would be justified, depends on the circumstances obtaining. A considerable number of animals have been vaccinated during recent years in TB-free herds and the serious difficulties anticipated in the interpretation of the test do not appear to have arisen. The freedom from anomalous tuberculin results can probably be attributed to the care exercised in the

TABLE I

REVIEW OF VACCINATION SUMMARIES FOR THE YEARS 1946 TO 1954
(Compiled by Mr. H. N. Spears, M.R.C.V.S.)

Year	Number of herds	Total vaccinated stock	Total unvaccinated stock	Cases of Johne's disease			
				Vaccinated		Unvaccinated	
				Diagnosed	Suspected	Diagnosed	Suspected
1946	66	588	3,523	2	1	83	40
1947	82	1,504	4,637	1	—	127	40
1948	85	2,527	3,915	5	7	115	78
1949	90	3,527	4,274	3	—	117	78
1950	84	4,276	2,883	5	3	97	67
1951	80	4,821	2,163	9	10	56	58
1952	74	4,824	1,843	16	20	44	30
1953	64	5,320	1,277	7	20	30	10
1954	56	4,664	1,040	9	14	14	7
				57	75	683	408
				132		1,091	

selection of herds for vaccination, as those only with good test histories were accepted. Each herd was submitted shortly before vaccination to the official comparative test, which is of considerable value in differentiating between the overtly tuberculous reaction and the small, non-specific reaction. The tuberculous reactor is removed from the herd, whereas the non-specific reactor is retained. This procedure, based on economic grounds, may, however, tend to leave in the herd animals infected with Johne's disease. Sikes & Groth (1950) made 855 tests with mammalian tuberculin in cattle naturally infected with Johne's disease and free from tuberculosis. When tests were read at the 48th hour, 49 per cent. gave either positive or suspicious reactions, and when read at the 72nd hour, 31.8 per cent. were positive or suspicious. Having regard to these results, the authors suggest that many N.L.V. (no visible lesions) cases may possibly result from sensitisation with *M. johnei*. The observations of Taylor (1949, 1950), Rankin (1954) & Smith (1954) on the isolation of *M. johnei* from apparently normal cattle is of interest in this connexion. The elucidation of the complex problem of the non-specific reactor presents many difficulties in both human and veterinary medicine, but it should be possible to determine the extent of *M. johnei* sensitisation by submitting an adequate number of these animals to cultural examination.

In tuberculosis-free animals vaccinated against Johne's disease, the avian tuberculin reaction is usually greater than the mammalian; occasionally the two reactions may be equal, and rarely the mammalian slightly the larger, but whether this results from vaccination or from a complicating non-specific sensitisation, is difficult to determine. We have shown that when tuberculin tests were made on vaccinated goats, kept in isolation, the mammalian reaction disappeared by the end of the second year, whereas the avian reaction was still pronounced at the end of the third year. When vaccinated goats were artificially infected with bovine tubercle bacilli, the comparative tuberculin test did not always differentiate between reactions induced by vaccine and those arising from the superimposed tuberculous infection.

Ritchie, Robertson & Muir (1952) reported that in artificially infected calves it was impossible to distinguish bovine type infection in animals previously vaccinated, and it was also impossible always to distinguish bovine type infection in infected animals which had subsequently been vaccinated. But limited field experience suggests that when a vaccinated animal has recently contracted natural infection with bovine tubercle bacilli, the size and intensity of the mammalian reaction facilitates diagnosis.

SHEEP

Johne's disease of sheep is of considerable economic importance, but relatively little attention has been paid to its investigation. It occurs in Europe, America, Canada, Britain, India, Iceland and New Zealand; and in general its distribution is similar to that of the disease in cattle. The bovine strain of *M. johnei* can infect sheep (Twort & Ingram, 1913), and one of the sheep strains can infect cattle (McEwen, 1939). It is believed that two distinct strains of *M. johnei* occur in sheep; one strain can be grown on artificial media, whereas attempts to cultivate the second strain have failed. The annual loss in affected flocks varies between 1 and 10 per cent. The clinical disease usually occurs between three and five years of age and generally shortly after lambing or after weaning. There is great loss of condition, the wool is harsh and pulls out easily, diarrhoea is not a constant symptom, but may occur. Loss of condition in sheep is almost invariably attributed to parasitic infestation, so when Johne's disease occurs it is usually overlooked and may become established in a flock before it is recognised. The disease causes particularly heavy loss in Iceland, and Sigurdsson (1955) estimated that in a period of 15 years it caused the death of 75,000 to 100,000 sheep. When there is an annual mortality from a chronic wasting disease in adult sheep, Johne's disease should always be suspected.

Heath (1955) examined intestinal smears from 214 sheep at an abbatoir and found that 46 (21 per cent.) were affected. This figure is considerably higher than that obtained from a more detailed examination of abattoir cattle (Taylor, 1949), and it may be that the incidence of the disease in sheep is already considerable in some areas. Sigurdsson (1955) observed that when the disease had been present for two years or more in an area the annual mortality was about 8 to 10 per cent. During a period of 10 years the usual control measures of early diagnosis and destruction of suspected cases were practised and although the spread of infection was slowed down, the disease progressed continuously. He used a heat-killed vaccine, prepared from a bovine strain of *M. johnei* suspended in mineral oil, for vaccinating sheep. He stated:

"We then used this vaccine in a controlled field trial including 289 vaccinated lambs and 266 unvaccinated controls on the same farm. The results were satisfactory in that no deaths occurred in the vaccinated group, but 16 in the controls, and at autopsy lesions were found in only 1.8 per cent. of the vaccinated sheep but in 10.8 per cent. of the control animals. It could be concluded that vaccination had not only prevented deaths from paratuberculosis but had also prevented clinically unsuspected anatomical lesions. The second, larger vaccination experiment was begun in 1950 and has thus lasted for four-and-a-half years and is still in progress.

"Four areas in East Iceland were selected because paratuberculosis was prevalent on most of the farms there. It had been present from 1953 in these areas but on some farms it had been introduced only recently. Mortality was very high in these areas and on some farms the infection was just beginning to cause heavy losses. A vaccination procedure under such circumstances would be put to a severe test.

"The experiment was carried out as follows:

"Half of the lambs on 141 farms were vaccinated in the autumns of 1950 and 1951; the other half of the lambs of the same farms were kept as unvaccinated controls. All animals were marked with aluminium

ear-tags showing their number and carefully recorded. In this way comparison of the fate of vaccinated and unvaccinated animals of the same age was made possible. This we considered important, primarily because of the well-known age variation in paratuberculosis mortality.

"These experiments will be continued for several more years but I shall show some of the preliminary results obtained up to the end of 1954.

"A table shows that out of 6,457 sheep 2,195 were recorded dead before the end of 1954. Intestinal specimens were received from 1,426 of these. Five hundred and forty-nine of these deaths were caused by paratuberculosis and 519 of them occurred in the unvaccinated group and only 30 in the vaccinated group. If we calculate with the mean number of sheep in the two groups during the experimental period this is a paratuberculosis mortality of 1.3 per cent. in the vaccinated group and of 21 per cent. in the controls. Mortality from paratuberculosis in the unvaccinated animals was very heavy in all areas, but very much lower, almost negligible in the vaccinated groups.

"All our experience with this new vaccine is with sheep; we have not used it on cattle. There seems, however, every reason to expect that it would be equally effective in preventing paratuberculosis in cattle. As far as we know the pathogenesis of paratuberculosis is identical in the two species. The virulence of the microbe is, generally speaking, not higher in cattle than it has proved to be in sheep in Iceland. It seems to me that the infection behaves so similarly in these two species of natural hosts that it should be permissible to expect similar results from a vaccination procedure."

As sheep are not subjected to tuberculin testing, there is no obstacle to their vaccination, provided the losses justify it.

Summary

Johne's disease of cattle and sheep is an international problem of great economic importance and urgency; and the evidence shows that it is being gradually introduced into new areas.

It has recently been proved that a considerable percentage of foetuses from clinically affected cows are infected.

It is now known that in addition to clinical infection at least 17 per cent. (probably more) of apparently normal cattle carry a latent infection.

The only practical method at present available for the control of the disease in heavily infected herds is vaccination. But unfortunately the close relationship between *M. johnei* and the bovine tubercle bacillus creates an obstacle to this procedure in countries engaged in the eradication of tuberculosis by tuberculin testing.

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THE SPEAKER'S INTRODUCTION

Mr. T. M. Doyle, introducing his paper, said: "First of all I would like to thank the Organising Committee of the Congress for their invitation to present a paper on Johne's disease; it is a privilege which I greatly appreciate. As this paper has been circulated, and as time is limited, I propose to be brief in introducing it. The only part of the paper to which I will refer is that dealing with the incidence and distribution of the disease. Until recently, although we knew the disease was widespread in the country, we had little information on its incidence, but many will remember that the late Major Dunkin insisted that it was the cause of heavy economic loss.

"When work started on the disease at Weybridge it was necessary first to ascertain the size of the problem and the steps which would be required to control it, and so a survey was started in 1946 which is still in progress. From the results obtained it is now clear that there is a high incidence and wide distribution of the disease in England and Wales; there is little information on the position in Scotland. There is a large-scale map at Weybridge on which each known infected farm is marked, it was not possible to bring the map here, but there is a small replica of it shown on the board. The number of infected farms shown is only a small fraction of those in the country. I think it would be no exaggeration to say that Johne's disease is one of the most important diseases of cattle and when it is remembered how helpless we are against it, it is probably the most important disease in Britain at present. It would be wrong to think that this is the only country infected—there are many others—but the full extent of the disease in them is not known and will not be known until a survey similar to that in progress here has been carried out. It would appear from published reports that the disease is being progressively introduced into new areas and countries by pre-clinically infected animals. I would emphasise that this is a disease of international importance, and it is on an international basis that it should be controlled. It will be noted that there is no reference in the paper to the complement fixation or blood test. This is mainly because I have no practical experience of it and partly because my colleague, Mr. Hole, who is responsible for the test, has published an article on it in the July (1956) issue of the *British Veterinary Journal.* The test has proved to be of great value for the confirmation of the disease in suspected animals in attested herds. Whether or not it is going to be of practical value for the detection of pre-clinically infected animals will take some years to determine."

The Openers

Mr. J. B. White (Salisbury) opening the discussion, said: "I have felt for a considerable time that a stock-taking was overdue on this subject of Johne's disease and I hope that at this meeting the various research workers on the subject will let us hear their present views. Before going further with my remarks I should like to congratulate Mr. Doyle on the able manner in which he has dealt with the subject, collating a tremendous amount of information with great lucidity.

"When one thinks about Johne's disease it is soon obvious how much there is to learn in spite of advances in knowledge over the last few years. We shall await with interest the information arising from the Ministry's survey of the disease which should give us valuable help in assessing just how big the problem is. When I look at the map which Mr. Doyle has shown I realise how far we are from a true survey at present. From the look of the map Salisbury appears to be virtually free from the disease; that is wrong, it is simply because we have not sent any samples for confirmation. I should like to know whether Weybridge want samples from all over the country, if they do I have no doubt they will get them in plenty.

"Mr. Doyle also mentioned a feeling of helplessness which we feel with regard to this disease. If you consider the diseases in which we have that feeling you will find that it is generally caused by a feeling of ignorance. As soon as we start to get to grips with a disease generally we feel on very much safer ground as far as our ability to deal with it is concerned. I am fortunate in being in an area where Johne's disease, although widespread, is not a serious cause of loss except on a relatively few farms. Looking back I would say that the disease was almost more prevalent in the early 30's than it is to-day, although there was a period of years in the late 40's when it became almost a rarity. Since then it has increased and become a serious cause of loss.

"In the period of quiescence we attributed the diminution to piped water-supplies and to the Accredited Scheme which encouraged a general cleaning up of farm premises and stopped bad practices such as, for example, tying calves behind the cows in the cowshed, and we find it difficult to account for its return, particularly in herds where clinical cases are limited to the odd case in the year. In many farms the condition is present but only the odd case appears now and then. I feel that comparatively few farms in my own area are free of the infection.

"On the farms where the loss is heavy there is usually some contributory negligence on the part of the farmer in retaining the clinical cases on the farm when they should have been slaughtered, as well as other faults of husbandry.

"I agree most heartily with Mr. Doyle that there is great importance in the sound rearing of young stock, and with the maintenance of a good level of nutrition. Parasitism in youth seems to go hand in hand with subsequent losses from Johne's disease. Is this because the small paddock or orchard, so often the source of the parasites, is also the pasture for the invalid, or is it that the gastro-enteritis of parasitism gives a better entry for infection as well as providing a debilitated host to give the Johne's infection a good start?

"It is interesting to consider the status of apparently healthy cattle in an infected herd. Do we know how infected are the non-clinical cases, and does not this disease more closely resemble tuberculosis than we commonly think in that, provided nutrition is good, little disease is seen? I do not think there is any doubt that malnutrition does exist on many farms; one has only to consider the anoestrus of a first-calf heifer to realise that nutrition is not adequate. It is not so easy to understand the importance of certain other factors which precipitate clinical disease such as a low soil *p*H, excessive rain with luscious grass growth, or the severe manifestations which are met with where sewage effluent is a problem. The clinical case, surely, is the final chapter when the animal's resistance has broken down and the

disease goes unchecked as in generalised tuberculosis. I say this because, in general, I think there are very few cases of clinical disease which can be brought back to a normal condition of health, whereas apparently a very large number of animals carry the infection, probably through the whole of their lives, and it never manifests itself as a clinical disease.

"I feel therefore that the number of infected animals and the number of infected herds is probably a great deal higher than is thought, and I would ask if there is any logical explanation for the greater susceptibility of the Channel Islands breeds.

"It is not the diagnosis of the clinical case which is our main difficulty but the selection of the non-clinical case or the proving of an animal to be free of infection. I find it difficult to understand how johnin can have much value as a diagnostic factor when we know how many avian reactors there are in attested herds which cannot all be latent cases of Johne's disease.

"I was hoping to hear whether Weybridge had reached any conclusion regarding the value of the complement fixation test. I realise that this is an experimental venture which has been placed in a difficult position by the public demand for a diagnostic, but it is time we tried to make a more clear assessment of its value. For my own part, I am prepared to consider a positive reaction as fairly sound evidence of the presence of Johne's disease; I am also happy with a straight negative, but I find the doubtfuls rather difficult particularly when there are 50 per cent., 60 per cent. or 70 per cent in a batch of animals all of which appear to be clinically normal. It creates doubts in the mind of owner and veterinary surgeon when it is without foundation in many cases. The position is difficult in a bull with a doubtful reaction going to market. Owners realise that it is better to test the animal before it goes to the sale so that if anyone asks for a test they can refuse to have it done and it does not prejudice their position in the same way.

"The information concerning the transmission of infection from dam to foetus while *in utero* came as a considerable surprise to most clinicians. The distribution of Johne's organisms throughout the body seems much more widespread than was originally thought and it must alter our conception of the disease. My experience of vaccination is very limited, but in those herds where it has been used it would seem to have considerable value. I agree that the attested herd scheme cannot be jeopardised in any way, particularly now that the single animal with open lesions can cause such havoc. At the same time, the value of Sigurdsson vaccine, which is heat killed, sounds promising and would not, I imagine, cause many allergic reactions. It might give protection in early life during the susceptible period and still not show a very great degree of sensitivity in a year's time.

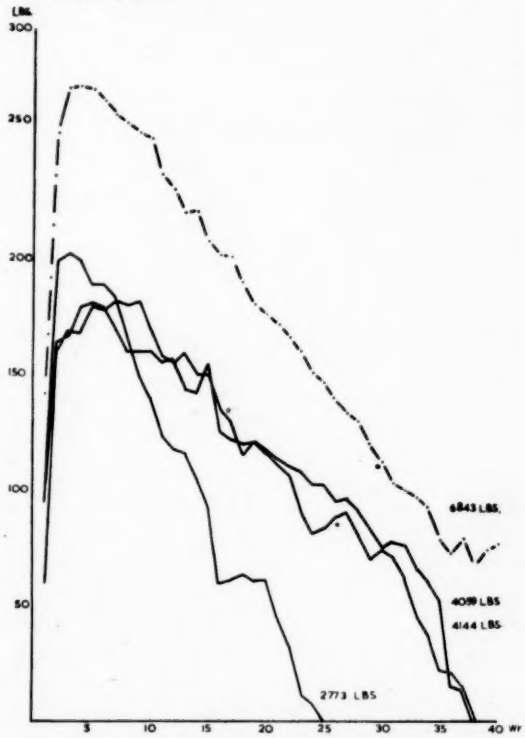
"Is the vaccine being tried out in this country? In the experiments on calves which Mr. Doyle has quoted where live organisms were injected subcutaneously were the glands examined culturally and was there any allergic response in the calves? It seems strange when one considers the widespread nature of the infection throughout the body that organisms could be injected subcutaneously without some risk of infection through other parts of the body at a later date. Has deliberate injection with avian organisms been tried as a means of vaccination during early calfhood? I would say that a fair measure of control can still be achieved by strict attention to calf rearing together with good management and good nutrition of the young animal and the immediate removal of clinical cases.

"I would like to ask if there has been any promise at all in the dressing of acid soils with lime in order to counteract the low *p*H value."

Mr. J. D. Rankin (Agricultural Research Council): "The Congress Committee's invitation to be one of the opening speakers to-day is a great honour to me. I feel the honour even more deeply as the author of this paper, Mr. Doyle (or T.M.D. as we youngsters know him), used to keep a fatherly eye on me when I first went to Weybridge 12 years or more ago. He used to come into my laboratory and ask kindly how the work was going. I would tell him and he would say very knowingly, 'This is certainly the room where all the work is done.' Coming from the Deputy Director that was high praise indeed. It took me a long time to find out that he said it in every room!

"Mr. Doyle has been interested in the problem of Johne's disease for as many years as I have been months, and it would be a presumption on my part to attempt to criticise his paper. I feel that my proper course should be simply to mumble something like 'I hereby declare this discussion well and truly opened' and sit down quickly. However, I am not allowed to do that as tradition says I must prove that I have at least read the paper by commenting on it. I had a look at the summary but Doyle has kept it so short that I was forced to go back to the beginning and very glad I am that I did so. I should counsel anyone who has not read this paper to do so at the earliest opportunity because in it is almost the sum total of the published knowledge of Johne's disease, clearly set down and not confused by so-called 'simple' tables and graphs. With that advice, I will now try to prove to you that I have read this paper.

"The best contribution I can make is to go through the paper recalling to your memory the various points covered and supplementing some of them from my own work and experience. There is no doubt from the figures and references given that Johne's disease is widespread in this country and that up to 17 per cent. of what are regarded as normal cattle are in fact harbouring the organism. Many of these Doyle says 'lose condition, milk poorly, and are finally culled from the herd . . . only a relatively small percentage of infected animals develop clinical symptoms.'



Graph showing the first lactation milk yields of three cows which became clinical cases of Johne's disease during their second lactation. The dotted line shows the mean milk yield of 20 similar cows kept under similar conditions.

"I have here a chart which illustrates the sort of thing that, in my opinion, is going on in our dairy herds to-day. The graph shows the first lactation milk yields of three

cows which became clinical cases of Johne's disease and died after their second calving. Plotted beside these for comparison is the mean milk yield of 20 similar first-calf cows kept under the same conditions. It will be seen that the three infected, but subclinical, cows gave 414, 405 and 277 gallons respectively whereas the mean yield for the group of 20 cows was 684 gallons—a difference of nearly 300 gallons.

"The minimum economic milk yield from a cow to-day is, I believe, 500 gallons so that these three cows would not have earned their keep in any dairy herd and would probably have been culled and sent for slaughter. I believe that the culling of dairy cows under circumstances similar to the above may be one of the reasons why the incidence of clinical disease in this country remains at 1 per cent. whereas that of infected but apparently normal cattle passing through our slaughter-houses is at least as high at 17 per cent.

"Turning to diagnosis, I would agree that microscopical examination of faecal smears is still the only way of making a positive diagnosis quickly and certainly. Unfortunately one cannot use the microscope to make a negative diagnosis, as only 30 per cent. of positive cases can be detected in this way, leaving 70 per cent. apparently negative. The best time to make a smear is when diarrhoea is present. I used to say that the only time to make a smear is when diarrhoea is present, but I may have to modify that opinion if some of the work of the Glasgow veterinary school bears the expected results.

"For the purpose of diagnosis allergic tests are practically useless. After an extensive review of the literature Doyle has summed the matter up in a single sentence on which I cannot improve: 'The repeated testing of heavily infected herds rarely, if ever, eradicates the disease.' Before leaving diagnosis I must remark on the omission of any mention of diagnosis by complement fixation tests.

"In a paper on Johne's disease to-day this is a serious omission which he has, to some extent, explained in his opening remarks. At this point I had a lot of questions to put to Mr. Doyle but in view of those remarks I shall now have to ask the questions and try to answer them myself. This I do not propose to do. I am, however, quite willing to answer, to the best of my ability, any questions on the complement fixation test put in this meeting but I must say that my experience is limited to groups of experimental animals and to animals selected because of some common feature from one or other of three herds.

"The Oxford Dictionary defines a 'whipping boy' as 'a boy educated together with a young prince and whipped in his stead when the prince committed an offence'. A whipping boy, I feel, had some privileges and, as I seem to be the whipping boy for the complement fixation test, I am going to rebuke the Weybridge workers mildly for being so secretive about it. Rumour has it that more than 100,000 samples have already been tested, yet the information available to the profession is negligible by comparison. Surely by now something definite must have come from all this work?

"In dealing with the relationship of age to susceptibility Doyle says that 'infection occurs during a variable period of early life'. I am in complete agreement with that statement but why did he go on to talk about the infection of adult cattle? In my opinion it still has to be proved that infection of adult cattle is of any importance in the spread of Johne's disease.

"What is the evidence given in favour of adult infection? Firstly, that Johne's disease occurs in animals of from 6 to 14 years of age. I have it on the authority of Mr. Blumer from Australia that a bull was imported into Australia as a two-year-old, was placed on a farm in a State where Johne's disease did not exist and that that bull died of Johne's disease when it was 12 years old. The fact that aged cattle die of Johne's disease simply means that the disease has, or can have, a very long incubation period.

"Secondly, Buddle *believes* that there is ample evidence from the field that adult animals may acquire infection. I have looked closely at Buddle's paper and that is precisely what he says, but there is not one fact in the paper to merit this conclusion.

"Thirdly, it is said that calves in this country, separated from their mothers at birth and kept in strict isolation, have subsequently died from Johne's disease. My answer to that is that these observations were made before it was realised how important intra-uterine infection could be in Johne's disease.

"Lastly, we have Mr. Doyle's own work on this subject. He tells us that he gave 'infected natural material *per os* to 12 susceptible Irish cattle.' He should not have used that word 'susceptible' because that is precisely what he is setting out to prove. We have been told the answer before the experiment has started. It savours a little of Lewis Carroll—'I have said it thrice, what I tell you three times is true.'

"In this experiment, an account of which was published in THE VETERINARY RECORD in 1953, of the 12 cattle dosed, two steers, aged 17 months and two years of age respectively, became infected. The *post-mortem* report showed that smears, sections and cultures of the intestine and/or lymph nodes were all positive, and there can be no difference of opinion here. I would point out, however, that these were amongst the youngest of the animals tested, the next in age being two years six months, then three years, etc.; up to six years. In my opinion they were not adult in the sense that they would be in the milking herd. Two cows aged five years nine months and five years seven months are also claimed to have been infected, but the *post-mortem* reports are much less convincing. In the one case smears, sections and cultures were all negative and diagnosis was based on macroscopic observations only, a very hazardous thing to do, and, in the other, smears and cultures were positive but no lesions were seen nor apparently were sections made. The evidence that these adults developed Johne's disease seems a little weak.

"Finally, there is no mention of the other eight animals; presumably they remained negative which I would have thought was strong evidence in favour of adult cattle being resistant—or not susceptible!

"I would like to ask Mr. Doyle if he would agree that this question of infection of adult cattle has not been proved and that it is time that it was settled one way or the other.

"On intra-uterine infection I have little to say except to supplement the numerous instances Mr. Doyle has given with some of my own experience. I have had four cases of recovery of *Mycobacterium johnei* from the uterine mucosa of clinically infected cows, and two from the mesenteric lymph glands of their calves.

"In Mr. Doyle we have the acknowledged authority on vaccination against Johne's disease. Certainly no person in this country has had one-half of his experience in this field, with the possible exception of his own countryman and colleague, Spears. It is not surprising therefore that I have little to add to this section. One thing, however, puzzles me somewhat, and that is that after stating that vaccination interferes with the interpretation of the tuberculin test he goes on to say that 'the serious difficulties anticipated in the interpretation of the test do not appear to have risen'. I wonder if Mr. Doyle can remember if tuberculosis was introduced into any of his vaccinated herds and, if so, was it discovered by means of the tuberculin test? The only investigation of this problem seems to be that of Ritchie, Robertson and Muir which Mr. Doyle has quoted, and which appeared in an article in *The State Veterinary Journal* but has not to my knowledge been published elsewhere. I would ask our colleagues in the Ministry not to confine their scientific writings to this privately circulated paper as it makes it very difficult for those of us who are not on the Ministry's staff to keep ourselves informed of their work. I make no criticism of *The State Veterinary Journal* which has progressed from a rather timid beginning to its present excellent form but there seems to be a growing tendency on the part of the Ministry's staff to regard it as a scientific journal, which it is not, and to publish in it exclusively.

"Time and again throughout the paper Doyle mentions the importance of interpretation in the control of the disease and we must agree when he says that 'to undernourish the growing animal is bad policy'. Unfortunately we see this all too often; straw and turnips are the staple winter diet of many heifers. I must say, however, that I would not

go so far as Doyle in condemning strip grazing outright; without the proof that an adult animal can contract Johne's disease it may well be that the economic advantages of this form of pasture management outweigh the hypothetical disadvantages.

"I have no personal experience of Johne's disease in sheep—we hear that phrase all too often—but the figure quoted of 21 per cent. in adult animals is indeed alarming particularly as it is based solely on microscopical examination of smears. If this figure is anywhere near correct it would seem to be a matter of some urgency to bring the sheep more fully into our investigations on Johne's disease."

The Chairman, Mr. A. L. F. Mullen, thanked Mr. Doyle for his introduction and the two openers for their very welcome contributions—he might even say intriguing contributions.

The General Discussion

Dr. R. F. Montgomerie (Beckenham) said that one of the most significant points which had been brought out was the increasing importance of Johne's disease in this country. Such rapid and commendable progress had been made towards the reduction of tuberculosis but it was clear from what Captain Doyle had written out of his own and the experience of others that in the absence of tuberculosis there was a considerable risk of having Johne's disease the major problem among cattle.

The second point he wanted to make was that he had thought one could go a long way towards the control of the disease by isolating the young stock. He could remember a number of occasions in his own experience in which, by calving under very careful circumstances and by very complete isolation of the young stock, considerable progress was made in reducing the incidence of Johne's disease and he was surprised that the progress had not been more complete. The answer was provided in the paper, and it might have come as a disturbing shock to quite a number of them to realise that there was this incidence of foetal infection which seemed to be one of the very important points which Mr. Doyle had made in this paper.

Thirdly, in reading the paper he noticed the word "breed" mentioned twice. Unfortunately, he did not underline it and on a rapid re-reading he had only found it on one occasion at the bottom of the introductory paragraph when Doyle says that to obtain some idea of the prevalence and distribution of the disease, as was being done in Britain, it was essential to make a survey of a representative number of herds of the various breeds of cattle in different areas. Was there here a suggestion that there was a breed incidence? He noted that Mr. White asked for further information on this point. Again, was there a greater susceptibility in the Channel Islands breeds? Perhaps in answering that point Mr. Doyle would bear with him if he asked him to be quite clear because he himself saw a great difference between the incidence of infection and the incidence of clinical cases of the disease. He hoped Mr. Doyle could develop that point a little further.

Fourthly, he had hoped, frankly, that there would be in this paper some indication of what steps would be taken in this country to meet the demand from overseas countries regarding the test for Johne's disease. They were so anxious that Johne's disease should not go to their countries that he knew from personal experience—and many in the room must be conscious of the fact—that there were importing countries which insisted on having an avian tuberculin negative test and which admitted that this was intended to be a protection against Johne's disease. There were some sufficiently old-fashioned to demand a negative test but recently there had been attempts to persuade some of these overseas countries that this test was better left in the limbo of the past, and that the complement fixation test was the better. It was, therefore, a disappointment to find that the complement fixation test was not mentioned in the paper. Mr. Rankin took up the point to some extent but he would appeal to Mr. Doyle to cover this very important question as to the advice which the profession should give to those concerned with the livestock export trade with regard to the testing of cattle going abroad, which would be reasonably certain to protect an importing country against Johne's disease without the tremendous fallacies which existed.

One saw from the paper the importance of Johne's disease in establishing its relationship to cattle. Captain Doyle had mentioned that there was one strain of the disease which would infect sheep but he would like to know whether there was any indication from experience up and down the country that, in point of fact, infection from sheep was transmitted to cattle.

The question of strip grazing was mentioned, and quite frankly he was prepared to cross swords with Mr. Doyle about this, but Mr. Rankin had made the first plunge and he would make the second. He doubted whether one should put forward anything which had a suggestion of real danger, or real disadvantage in one of the most important, relatively modern, agricultural practices. Mr. Doyle had already been challenged as to his evidence that adult cattle did become infected with Johne's bacilli. So far as he himself knew, strip grazing was always confined to adult cattle and he would suggest to Mr. Doyle that he should not raise this matter unless he had very good evidence of his contention.

Mr. Rankin took up another point; he read an interesting observation in the paper, looked up the reference and discovered it to be from a paper published in *The State Veterinary Journal*. This was an important finding not published in a scientific paper, according to Mr. Rankin. He did not know the journal, it did not come to his hands at all, and an important journal in which important articles were published should be generally available. Perhaps he was "off" the subject of the paper but this seemed to be another example of a most unfortunate happening—papers of real importance to the whole profession being published in a journal not accessible to the majority.

Mr. P. L. Brown (Wiltshire) said that he had been in general practice for about 12 years and he had seen a fair amount of Johne's disease and was very interested in this paper. He agreed with the previous speakers with regard to nutrition and good management and thought one could possibly be a little more precise about the sort of factors involved. His own opinion was that calcium intake and possibly calciferol were the most important. He wondered if Mr. Doyle had any information on the soil *p*H and calcium status of the land on which such drastic losses had occurred in Eastern Iceland and whether he knew any link between the *p*H of the soil and the calcium intake in the worst areas in this country. It might be that in Mr. White's area they had not experienced the heavy losses of the low *p*H areas, and that might be the reason why Mr. White only got odd infected animals within herds and not large percentages in herds.

With regard to calciferol; he had in the past treated a number of animals with large doses of calciferol and seemed to obtain a sufficient abatement of symptom in some cases to enable the owner to pass them on elsewhere. He tried it because of the use at that time of calciferol in large doses for tuberculosis in human beings.

As a practitioner he regarded the complement fixation test as the most important advance in diagnosis and control of Johne's disease which they had ever had. He found positive reactions remarkably consistent with clinical findings and whereas in the past he had regarded the sending of faeces samples as a waste of time, he had developed the utmost confidence in the complement fixation test for the confirmation of his suspicions.

There were various points on which he would like information. He would like to know how long a period elapsed between the original infection and the development of a positive blood reaction. He suspected it was very short, possibly a matter of weeks. A lot had been said about the infection of adult animals; did they mean infection of these adult animals with subsequent development of clinical disease or simply infection of adult animals without the subsequent development of clinical

disease—two very different things. He had a herd of his own which was established on land which had not carried cattle for many years previously. The cattle were purchased from a number of sources and during the first year two animals were slaughtered because they were clinical cases of Johne's disease. He went to Weybridge and heard for the first time about the complement fixation test and decided to try it in an attempt to eradicate the disease on the farm. It so happened that records were kept of the movements of the stock from one part of the farm to another. Therefore one knew within days when certain animals could have acquired infection from these clinical cases. He was able to trace the blood histories of all animals thereafter and a number of positive reactions were obtained from animals which were previously blood negative. It was known that the animals had only acquired infection within the previous three or four months and it was assumed that the distribution of infection was mainly in the gut and associated lymph glands. He was not so much worried that they would develop clinical disease, as that they might become symptomless carriers. They were mature animals and he thought it worth while, acting on the assumption that the infection was probably confined to the gut and adjacent glands, to try to kill it in that site. At least he thought it would be a safety measure because he was grazing intensively at a rate of more than one beast per acre.

He tried streptomycin as a shot in the dark on an extended course, giving it for five weeks with one week off in the middle of the course. Taking blood tests after this he was surprised to find that his positive reactors had become negative. He wondered if he might draw an analogy here with the elimination of blood positive reactors in pullorum disease with the use of the nitrofurazones.

Mr. Doyle gave details of generalised infection with Johne's bacilli in clinical cases, but was there any evidence of a generalised dissemination in a latent or carrier cow? Had the bacteriological investigations of Smith been confined to attempts at isolation of the bacilli from the gut and ileo-caecal lymph nodes? This was most important as, if the infection was limited in the carrier cow to these sites, it did give a chance of destroying recent infections by using gut stable drugs provided there was a reliable test for early diagnosis. Furthermore, if it was only the clinical case which had generalised dissemination it was still possible to control Johne's disease by isolating the calf, because if calves born of healthy mothers only were kept there was little chance of them sustaining an intra-uterine infection.

With regard to vaccination, he felt with Johne's disease as he did with brucellosis that it would never be eliminated by vaccinating it out of herds. In any event he did not think the Ministry viewed with approval the extended use of vaccine at the moment. From his own point of view in trying to build up a herd he would sooner purchase an animal negative to the complement fixation test than an animal which had been vaccinated with Johne's vaccine and which depended for its immunity on the continued presence of live bacilli somewhere in the body.

Mr. W. A. Scott (Bedford) spoke as a young practitioner. He had recently taken over a Jersey herd which had a history of Johne's disease. It was on strip grazing. The complement fixation test was started at six-monthly intervals but he found that an animal which was positive on the first test might be negative on the second.

Reference was made to Mr. Smythe's remark about relatively little infection in Cornwall. He would have thought Cornwall had the lowest calcium level in its soil in the whole country. Mr. Smythe did say that Johne's disease was not prevalent in Cornwall although the speaker thought he would find that it was much higher than formerly. Coming from Cornwall two years ago he thought the highest incidence was in imported Ayrshire cattle. He would like to have comments on the complement fixation test from that point of view. He had been told that an animal which became negative was at the time of the test not actively excreting Johne's bacilli.

Mr. A. J. Wright (Macclesfield) congratulated Mr. Doyle on his excellent paper and for condensing such a wide subject so lucidly and yet so interestingly. He would like to bring forward two points, both of which he realised were controversial; he also realised that he was on dangerous ground!

The first point was the question of breed incidence which was mentioned by two of the speakers. Many people in practice had gained the very strong impression that the yellow breeds seemed to have a greater incidence of clinical Johne's. Whether that was due to a breed idiosyncrasy, or whether it was due to the fact that the Jersey and Guernsey stock were highly pedigreed and were kept a long number of years and had not the commercial killing out value and one saw more of them, he did not know. The commercial herds, at the first signs of Johne's disease, were sent to the slaughter-house and the veterinary surgeon did not see them. In spite of these factors many people still thought that there was a greater incidence of clinical cases among these breeds.

Mr. White mentioned, and he thought everyone would agree, that in the 30's with improved housing, improved feeding stuffs, the abolition of pits of stagnant water, the incidence of clinical Johne's did drop considerably, yet within the last decade it had increased tremendously and he sometimes wondered whether the re-seeding and production of lush grass feed which induced a semi-diarrhoeic condition almost throughout the year was responsible for the increase in clinical cases. Could this diarrhoeic condition be the trigger mechanism that might start many clinical cases. Whilst admitting that malnutrition did play a great part in Johne's disease it was a peculiar fact that Johne's disease was often found on good modern farms.

A large part of his own practice was on the marginal lands of the Pennines and the other part was on the plains of Cheshire. There was not a high incidence of clinical disease on the marginal hill lands where the re-seeding was not brought to the same high level as on the plains where, on the small farms, every square inch of land was re-seeded. It was in the hill farms where there was often malnutrition and if it was the only factor there would be more Johne's disease on the hill farms than on the plains, but it was a fact beyond doubt that the highest incidence was on the good farms on the Cheshire plains.

He would like to ask the experts on the platform if they had any experience to bear out that observation, and whether they thought that the question of re-seeding the spread of diarrhoeic material over the pastures and the animals being in a semi-diarrhoeic condition over the whole year, had anything to do with the increase in Johne's disease, or had the least effect on it?

Mr. Peter Robinson (Cheshire) said that he had risen to speak following on Mr. Wright because he farmed in Cheshire. During the last 10 years in which he had been more closely associated with the farm and the farming had been more intensive, Johne's was a definite problem. The young stock were well fed but in spite of that the disease was a headache. Two years ago he resorted to the complement fixation test. He bred the dairy Shorthorn; these were fewer in Shropshire and Cheshire, but from his tests in practice he thought it was the breed which showed a greater tendency to the disease.

After the complement fixation test two years ago on 180 head the picture was not very good, the number of adult cattle giving a positive, weak positive and doubtful, amounting to 20 per cent.; but in the young stock up to three years old there were 5 per cent., which gave an overall percentage of 15 per cent. suspects. He kept valuable cows and the possibility of eradicating the condition quickly or moving them out was economically impossible; he could only move them out to the slaughter-house and they were too valuable for that. He tried to keep an eye on all the positive cases and to follow up subsequent blood testing on the young stock because he felt that there was his greatest hope of stopping the spread and he would not lose so much.

Subsequently he had three or four clinical cases in young stock or heifers which had just calved, and one in a four-year-old animal. Two had been weak positives and two had been doubtful. He did not have a case among the cattle which had returned a positive reaction. Since the second herd test one year later he had been in a very much better position. In the adult cattle there were the same number of positives and a few variations of degree, but many doubtfuls had become negative, while in the young stock up to three years old all had been negative. In the previous year, just prior to a batch of heifers calving down, there were two weak positives which became clinical cases; this year the similar bunch were all negative, they had all calved down and there had not been any clinical cases among them. He was therefore beginning to put a lot of trust in the complement fixation test. The testing of the non-reactors would go a long way towards keeping down clinical cases. It was a test with great possibilities, contrasted with the avian tuberculin test which had not been of any help at all.

Mr. R. S. T. Bowden (Veterinary Research Institute, Ipoh) said that Mr. Doyle mentioned the international aspects of any measures which might be put forward to control Johne's disease, and he could only speak from his experience in Malaya which must be less than that of anybody else in the meeting. With the exception of two cases, so far as he was aware, they did not get Johne's disease in Malaya and it was important that they did not get it.

With reference to the two cases, although it might not help very much, one occurred before he went out and was the case of an animal imported from India, nine years or more old. It was a clinical case of Johne's and at *post-mortem* it was positive for acid-fast bacteria. The second case was recent, in an animal imported by the Veterinary Department for improvement, a Cintra bull from Pakistan. It was a positive case. Looking at the animal, although he had not seen a case for many years, he thought it looked like Johne's disease and at *post-mortem* it was definitely so. On an exhaustive microscopic search, however, no bacteria were found from the lymph nodes nor were there any extensive lesions in the bowel. He made a fresh lot of material and it was still negative, material was sent to another institute and it was negative there also.

He would like to ask Mr. Doyle if he had any idea of the percentage of negative to positive in scrapings and examinations of faeces for microbacteria in cases of Johne's disease.

Incidentally, he did not know whether it was climatic, or what was the reason, but the incidence of tuberculosis in cattle in Malaya was extremely low. That statement was based not only on testing but on abattoir examination and so on. Perhaps the hot climate prevented the development of the organism. Human tuberculosis incidence was very high.

Speaking from the international aspect, and from a country which so far as one knew was completely free of the disease, any test such as the complement fixation test would be very well received. They had to import cattle and were open to infection from outside sources.

Mr. J. N. Ritchie (Chief Veterinary Officer) thought that this discussion was of real importance because it dealt with a disease which was causing great difficulty at the present time. He found it difficult to appreciate what the real distribution of the disease had been, but there was little doubt that it was widespread. It was suggested that in recent years the disease had become far more important than before and one had attempted to look at the possibilities to see why that state of affairs had arisen.

His own belief was that during the years when a major attempt was being made to eradicate tuberculosis there had been a tremendous movement of stock throughout the country as a whole; for instance, many a herd owner who had a high incidence of tuberculosis had got rid of the herd and had obtained a tuberculosis-free herd from a number of sources. As he had multiplied the sources of animals so he had increased the risks of bringing in all sorts of other diseases to the new herd. If it had not been for the fact that a great deal of vaccine was being used against *Br. abortus* that disease also would have become extremely serious in these particular circumstances. He suggested that that might have had a good deal to do with the incidence of Johne's disease in this country at the present time.

There were, he thought, from the research which had been done, two specific lines of approach to the control of this disease in addition to the ordinary observation of good husbandry. Firstly, the possibility of the use of vaccine, and, secondly, the possibility of the employment of the complement fixation test as a basis for eradication of the infection from the herd.

With regard to the use of vaccine, a fair amount of work had been done on this but the experiments which had been done in the field had been carried out without controls. It was proposed shortly to try to run an experiment using adequate controls and looking not only to find out whether the vaccine was a good one against Johne's disease but also to try to see what real effect it had in practice on the tuberculin test and the interpretation of it if infection with tubercle should reach the herd. He put a great deal of weight on the possible danger of interfering with the tuberculin test by the use of this vaccine and he thought we were now at the stage when the eradication of tuberculosis would seem to be within sight. Those people who forgot that tuberculosis was a really serious problem in herds in the past were those who were inclined to suggest that the vaccine should be used without precautions so far as tuberculosis was concerned. His own view was that the success of a scheme which was rapidly coming to its close should not be jeopardised by using the Johne's vaccine prematurely and until the precautions which must be taken were known.

Dr. Montgomerie and, he thought, Mr. Rankin very rightly said that the Ministry did publish some information about the interference of vaccine with tuberculin testing. In view of the fact that at a previous discussion in the Association he had outlined the results of that experiment, he would not go into the details now, but, very broadly, the result was that all the vaccinated animals in the experiment did show reactions, albeit with a tendency to react to a greater extent to the avian tuberculosis. When tested later the animals which had been infected with bovine tuberculin before vaccination, and those which had been infected subsequent to vaccination did not appear to show any different test result from the animals which were straight vaccinates, and he would suggest, and, indeed, warn his hearers, that this was a preliminary experiment with only a small number of animals in each group, but it was sufficient to show that they should beware of using the vaccine in a widespread way until a good deal more was known about it. That was what it was proposed to find out in the experiments which were pending.

He thought also that there was a tremendous potentiality in the use of the complement fixation test. Dr. Montgomerie had referred to the possibility of its use for animals being exported from this country. It was being used for a number of countries, and one's job in so far as these animals were concerned was mainly to do what the country demanded. It was usually the importing country which laid down the conditions to be observed and it was the function of the Department to see that they were observed.

Some work had been done on stock which had been exported from here to Canada which did not require a complement fixation test at this end. They were tested in quarantine in Canada and the results obtained bore out the certifications which were made on this side. He felt therefore that if there was a demand for a complement fixation test as an adjunct to any clinical surveys and certification of the herds of origin, it would not be tremendously difficult for these conditions to be observed. He did feel that in so far as the eradication of this disease from the herds was concerned, they should be a little patient and await the results of the work which was being done at Weybridge and which would be summed up and published in a scientific journal.

Mr. A. Steele Bodger (Lichfield) said that several reasons had been suggested for the apparent increase in Johne's disease. He gathered that before the war it began to get less common and now it was once more on the increase. Might it not be that before the war farmers knew little about worms? There was the introduction of efficient vermicides and now he felt that either the worms had got resistant or the vermicides were less efficiently used. He felt that some of the apparent increase might have been due to such a cause.

Another point was that some little time ago, in taking cases under a Tuberculosis Order from herds in the district he took careful scrapings from bowel sections. He knew that there was a small section in the clinical report form concerning other *post-mortem* findings but it took him longer to find out whether Johne's was present than to send in the form so that they were not recorded! Actually 67 per cent. of the animals in 18 months with confirmed tuberculosis had Johne's disease as well. Many of these animals came from herds which had since become attested and the owners now complained that Johne's was on the increase. They felt they would far rather have herds with tuberculosis than with Johne's from the point of view of eradication. They were similar complaints and there might be a certain amount of competition between them for the animal's body. Tuberculosis was a quicker killer and if an animal had tuberculosis and Johne's disease it would probably die from tuberculosis. If tuberculosis was eradicated one was left with Johne's disease with no competition and it might become a clinical case.

With regard to the complement fixation test, it was obvious that many practitioners had tremendous faith in it. He had, and clients whose herds were regularly tested believed in it implicitly. In his opinion it was successful but this last week an animal which was negative in the complement fixation test was found to be positive on *post-mortem*. One could not examine all these animals at *post-mortem* but when the farmer had them slaughtered locally he got the necessary material to send to Weybridge. Since so much faith was put in this test, and since Weybridge was the only laboratory which interpreted the results, could they not enlarge their staff so that more of these tests could be carried out? They need not accept responsibility for what practitioners did, but obviously they all felt that there was something here which assisted them. Two years ago one took the bloods, sent them to Weybridge and back came the answer. During the past twelve months he had not yet received permission to test a single fresh herd; he gathered it was due to shortage of staff, and that if they increased the staff the Ministry of Agriculture had to give the test their official blessing as a diagnostic agent. The C.V.O. had just said that "there was something in it" and he would plead that something more might be done to hasten its application.

With regard to sheep, he would like to know whether Mr. Doyle had any information on what he believed was a connexion between Nematodirus infestation and Johne's. He believed that at Lasswade they felt that there was some affinity on the Borders between the two conditions.

Dr. A. W. Stableforth (Weybridge) said there was one question he would like to ask Mr. Rankin. He had said that one of the important factors was the difference in the production of milk between experimentally infected animals which developed Johne's disease in their second lactation compared with those which were not infected at all. He would like Mr. Rankin also to say if he knew whether there was any difference between the whole group of animals which he exposed to infection and the group which were not exposed at all. It was quite possible that animals which never showed clinical symptoms might also show a difference in milk yield as compared with unexposed animals.

With regard to the last point, blood tests in Johne's disease, the C.V.O. had said "We think there may be something in it; it is a valuable way, probably, of showing that an animal is not infected provided the animal is mature," and that was an important provision of which Mr. Hole had constantly reminded them. His own view was that the test was probably of no value until there had been a definite tissue reaction in the animal. It was known also from the Compton work that animals could actually excrete Johne's organisms and yet be negative to the test. Mr. Hole had taken the view that it might be that they were taking in the organisms and excreting them and not being affected by the disease. One did not yet know, however, whether that was the answer.

He thought they should go easily with this test at the moment; it was in its experimental stages; if other countries liked to adopt it they could, of course, do so. A number of herds had been spoken of where it was used for eradication purposes, but it would be realised that the knowledge now extant with regard to congenital infection made one realise that eradication was even more difficult than they previously thought. Their own work at Weybridge and the V.I. laboratories would be summed up at the end of the year. In the meantime, he would ask the profession to be patient; it was not possible to lay on more staff to carry out more tests of this kind, their research workers had to be deployed in the way which would bring the best results in the end.

Mr. J. McC. Ingram (Oxted) thanked Mr. Doyle for his paper, and the interest he had taken in this disease for so many years. Mr. Steele Bodger had stolen some of the remarks he was about to make but he personally did not think there was any doubt in his own mind that there was a distinct immunity between acid-fast bacilli. Whatever the faults of dealers might be they were astute, and when presented with a cow with Johne's disease they bought it because they knew it would most probably be free from clinical tuberculosis and they could sell it as beef.

Another point he would like to stress was on the age of infection which he felt certain occurred in the early days of life. That brought up the point of milk production. The good owner could spot Johne's disease long before it became a clinical entity by using the falling milk yield as a guide. He knew one farm where some cows purchased at a dispersal sale had a disappointing milk yield. These cows were removed from the milking herd and were put on the farm where they reared the young stock, to suckle the calves. The low milk yield was the precursor of Johne's disease in these cows and the incidence of Johne's disease in three or four years was simply appalling; out of roughly 90 to 100 milk cows 25 were disposed of in one year with clinical Johne's disease, and they had all been reared by the cows he had mentioned.

So far he had been fortunate in vaccination. One of the herds in his area vaccinated against Johne's disease was vaccinated in this way: there were controls—two animals were vaccinated, and one was left as a control. The owner had no choice whatever in saying which should be vaccinated and which should be controls, and the controls eventually died one by one, whereas the vaccinated animals lived. He did not think there was any doubt that there was a danger in vaccination but he had been fortunate and had not met a case of the introduction of tuberculosis into a herd which would be difficult to diagnose because of the difficulty in interpreting the tuberculin test in vaccinated cattle. He was quite certain that vaccination had a distinct place in the control and eradication of the disease—a disease which was giving rise to an ever-increasing economic headache to the farming community.

Mr. J. G. Murray (Ledbury) said that there was just one point on which he would like enlightenment. Several speakers had referred to the fact that although there was little doubt in their own mind that there was some antigenic similarity or relationship between bovine tuberculosis and Johne's disease, nevertheless, the avian test was an unsatisfactory method of diagnosis. One noticed frequently in herds in which clinical Johne's disease occurred that when one was doing a tuberculin test one found in calves of a few weeks old very pronounced avian reactions and one wondered whether these animals were in the early stages of Johne's disease. Did Mr. Doyle think that these high avian reactions in very young calves

were the results, in many cases, of incipient Johne's disease? And, did Mr. Doyle find that animals infected with Johne's disease showed sensitivity at some stage or other to avian tuberculin, albeit that such sensitivity might be very transient?

The Reply

Mr. Doyle, in reply to the discussion, said that one of the impressions he had got from the discussion was our lack of knowledge of many important aspects of the problem. Those who worked on the disease were a little dissatisfied with the progress being made. He had recently re-read a number of publications by different workers in this country and he was surprised at the amount of work accomplished and the considerable progress made in the last seven or eight years. One naturally asked why even more progress was not being made. Johne's disease occupies a peculiar position among the major diseases. It will be found that with other major diseases, *e.g.,* brucellosis, vibriosis, swine fever, mastitis, etc., investigational work is being carried out in many parts of the world and the results published in journals which are available to those working on the particular subject. But in the case of Johne's disease, apart from Britain, Iceland and recently New Zealand, there has not been a worth-while contribution in the last 20 years from any other country. That is one of the main reasons for the slow rate of progress. He had not referred to the blood test because, as already mentioned, he had no practical experience of it and also because it was still in the experimental stage. However, Mr. Hole would be very pleased with the favourable comments on it. He should have started off by thanking Mr. White and Mr. Rankin and the other speakers for their kind remarks.

No further faeces samples were required at Weybridge as this work was now being undertaken by the Veterinary Investigation Officers. Are the Channel Islands breeds more susceptible than other breeds? In their figures of infected animals, Shorthorns showed the highest percentage, but more samples were examined from Shorthorns than from any other breed. The stronger breeds stood up best to the disease but in the end all clinically affected animals died; affected Channel Islands cattle usually died in a relatively short time. There were relatively few Channel Islands herds in the North of England yet it was one of the most heavily infected areas.

As regards Sigurdsson's dead vaccine, everyone would agree that, all things being equal, a dead vaccine was preferable to a live one. But with a dead vaccine it was necessary to use 8 to 10 times more organisms than required in a live vaccine. There was no danger of infection from live vaccine as it was made from old laboratory strains of *M. johnei* that were devoid of virulence. The World Health Organisation, in connexion with their B.C.G. vaccination scheme, had made extensive experiments on the relative value of dead and live vaccines and had found that it took one hundred times the standard dose of dead vaccine to give the same protection against virulent tubercle bacilli as a 1/1,000 dilution of the living vaccine. McDiarmid pointed out that it took 10 times the dose of brucella organisms to equal one dose of living (Str. 19) vaccine.

There was no reliable information available on the effect of different soils on the pathogenesis of the disease. French observers claimed that acid soils and those deficient in certain minerals—phosphoric acid and calcium carbonate—favoured the persistence of the infection. The fact was that no investigation of the effect of soil on the incidence of the disease had yet been undertaken.

With regard to the artificial infection of adult cattle, this work had been carried out on Irish cattle obtained from a Johne's-free area and from a farm where no case of tuberculosis had occurred in living memory. The animal to which Mr. Rankin referred had lost condition, excreted numerous *M. johnei,* but no organisms were found when *post-mortem* examination was made at a later date. He was of the opinion that some adults could become infected. At the O.E.E.C. seminars held in Weybridge (1955) the European representatives were emphatic that adult cattle could pick up infection. If adult cattle were resistant to infection why bother about a piped water supply and stagnant pools? Dr. Montgomerie had mentioned foetal infection: up to the present this had been proved only in the foetuses of advanced clinical cases.

As regards the transference of infection from sheep to cattle, Sigurdsson was of the opinion that this had occurred in Iceland. *M. johnei* were often difficult to find in intestinal smears of chronic cases. The question of a disease simulating Johne's disease had been reported on several occasions from the field but he had no personal experience of it.

Mr. Rankin thanked Mr. Doyle for clearing up the point with regard to susceptibility. He saw that he meant "not immune" in the sense that an antibody was not present as a result of contact with an antigen. He felt that Mr. Doyle as the speaker should have the final word on the question of adult infection. Mr. Brown expressed a high degree of satisfaction with the complement fixation test and so did other speakers, and he was sure he and his colleagues were gratified that that was so. In Mr. Brown's case he was emphasising the fact that he was dealing with what he called clinically suspicious cases, and these were the very animals with which, in his experience and in that of Mr. Hole's, the test was most reliable. In such an animal, it was true to say, the test would have an accuracy of somewhere in the region of 96 per cent. Mr. Brown also asked the period within which a positive blood reaction might be expected to occur after infection. He could only give his experience from experimental infection which was not necessarily applicable to a field experiment. His experience was that the earliest positive blood test occurred four months—generally speaking it was five or nine months—afterwards, and at that stage they were not showing clinical signs of the disease.

Mr. Scott and other speakers mentioned that the blood test was positive when the bacilli were in the gut and there was some hint that when the organism was not in the gut that the test would be negative. This seemed very remarkable, he did not know whether it could be proved or disproved, but he thought it would be a most extraordinary serological test which could have such a degree of selection in its action that when the organism was actually causing disease, as opposed to just being in the system, it would give positive reactions, whereas if it was in the lymphatic system only it would give a negative reaction. He did not know the answer to that.

Mr. Wright mentioned methods of hygiene and he would add something to that. He mentioned the increase in the risk of clinical Johne's disease by keeping animals in a constant state of near diarrhoea. His own experience of keeping experimental calves was that if these calves were carefully fed small feeds three times a day instead of the usual feeds night and morning, if antibiotics were added to the milk or milk substitute and every precaution was taken to ensure that they did not scour before they were infected with *M. johnei* it was much longer before clinical symptoms developed in such calves than in calves which had been scouring during the first month of life.

With regard to Mr. Ritchie's remarks, one could only agree that it would be foolish at this stage to do anything to jeopardise the excellent progress of the attested herd scheme. It would appear that we must wait only a few more years for a more or less complete freedom of the bovine population of this country from tuberculosis, and it might not be a great sacrifice to let vaccination wait until that time. This should be regarded as a breathing space, and in the meantime they must get to know as much about vaccination as possible so that they would be in a position to use it to the best advantage as soon as Mr. Ritchie, or the Ministry of Agriculture through him, gave the all clear.

Dr. Stableforth put his finger on a very important point with regard to the milk yields. The slide was got out rather hurriedly and in point of fact the milk yields of as many experimental cattle as possible were being studied. The group which he illustrated comprised the whole of one group of experimental animals which were exposed to infection by contact at six months of age. There was only one other animal in this group but it failed to get in calf. In the meantime they were looking at animals which had been experimentally infected in other groups and this table would

be supplemented to see whether this indication, which was only given as an indication, was representative of what might be occurring.

Mr. Doyle, adding to his reply, said that there was one point with regard to intra-uterine infection. This work was started by Mr. Lawrence of the Veterinary Investigation Service and they had confirmed his observations. He would also like to say that a great deal of the credit for the good results of vaccination was due to Mr. Clark and Mr. Macrae of the Ministry who examined the tuberculin test histories and selected only those herds which were free or almost free from non-specific reactions.

The Chairman said he was sure the audience would like him to thank Mr. Doyle and the two official openers, Mr. White and Mr. Rankin, for their very excellent and stimulating contribution to the paper. He would also like to thank those who had taken part in the discussion. He was not surprised that this subject resulted in a stimulating discussion which gave him, as Chairman, a personal satisfaction. It had been thoroughly enjoyable and most profitable.

Farm Health Problems—
Where Does Britain Stand To-day?

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Introduction

WHEN invited to give this particular paper at the 1956 British Veterinary Association Congress, I accepted, almost without demur, because it seemed an excellent opportunity to take stock of the post-war achievements in the maintenance and improvement of the positive health position in our farm animals. I realised full well that the successes have been many, the failures few. Consequently, I naturally assumed little difficulty would be experienced in preparing a very satisfactory statement of account. This expectation of ease was not realised; I soon discovered that the post-war triumphs had been so numerous and so varied that great care was required to keep this contribution within manageable proportions.

A major requirement for the effective control and treatment of diseases is a thorough understanding of the factors contributing to these diseases. To-day the position of the veterinary surgeon in a large-animal practice is far better than it was before the war, in that there is now a remarkably high level of assistance available to him by way of investigation and laboratory diagnosis. In this connexion the contribution of the enlarged Veterinary Investigation Officers' Service must not be overlooked, ancillary as it is to the work of the large centres of research. The total influence on animal health, although difficult to assess with accuracy, must be tremendous.

In the period under consideration, the veterinary profession has received a great deal of encouragement by sharing in the work of the Animal Health Division in effectively prosecuting the various schemes for the control—even the eradication—of diseases of farm animals. Certainly the profession has risen nobly to the opportunity afforded and, as a result, I declare my belief that avoidable loss from animal diseases is to-day much less than before. Unfortunately, all too frequently, accurate information concerning progress is difficult if not impossible to obtain, owing to lack of good statistical evidence of the disease position. The efforts which have been and are being made, both by this Association and by the Animal Health Division, to collect reliable data on disease incidence are to be warmly applauded.

In view of the wide field to be covered, it has not been found possible to give credit in this paper to individual workers or to give detailed references to publications.

On reflection it seemed advisable to deal with farm health species by species, and to pay attention to infections, parasitism, heredity, metabolic disorders and management.

It is with a feeling of nostalgia one accepts that the horse is no longer a farm animal of importance and can therefore command little or no attention in this reckoning.

Cattle

Undoubtedly the outstanding accomplishment of the veterinary profession in recent years has been the progress made in eradicating tuberculosis from our herds of both dairy and beef cattle. An excellent account of this whole project was provided by the Chief Veterinary Officer, when he addressed the Farmers' Club in October, 1955. In writing this section of the paper I have drawn freely on the report of that meeting. For many years, before the advent of the Tuberculosis (Attested Herds) Schemes, pioneer veterinary surgeons and farmers had been making heroic efforts to eradicate bovine tuberculosis from a few herds. Only a quarter of a century ago 40 per cent. of dairy cows were infected. Now, 20 years after the introduction of these schemes, more than half the cattle in the country are attested. The existence of large attested areas, and the confident anticipation of complete eradication of this scourge in the foreseeable future, is a remarkable testimony to the foresight of the pioneers to whom reference has already been made, to the skill of those who evolved and improved the tuberculins, the methods of using them and of interpreting the results and, especially, to the energy of the whole-time and part-time staff of the Animal Health Division. Viewed both from the health benefit derived by the public, and from the saving effected by the agricultural community, the achievement is nothing short of miraculous. Is there in this room anyone of 10 years' professional standing who, in his or her early days, contemplated this being achieved in 1956? Truly, the remarkable progress made in this field can be claimed as a post-war triumph.

Unfortunately, Johne's disease still causes a great deal of concern on many farms in this country. The losses from this condition are perhaps as great now as ever they were and, in some instances, have been catastrophic. Much was expected of the vaccine consisting of *Mycobacterium johnei* in oily excipient. However, although this afforded a high level of protection, it sometimes caused an unsightly swelling at the point of injection and also interfered with the tuberculin test. The first of these objections has now been largely overcome. Lack of a reliable method of diagnosis at all stages of the disease is a serious handicap when attempting to control this condition. The complement-fixation test has been used for the detection of infected animals and has enabled control measures to be adopted with success in a number of infected herds; but a more effective

diagnostic method is required. Recent confirmation that the disease can be congenital emphasises the difficulties associated with its eradication.

A further remarkable success is that of eliminating *Streptococcus agalactiae* infection from so many of our dairy herds by the use of antibiotics, particularly as part of the "blitz" treatment for which idea the Weybridge workers were responsible. It is true that the eradication of this particular infection does not necessarily mean the end of mastitis in the herd. Nevertheless, those who remember the earlier high incidence of *Str. agalactiae* mastitis in our dairy herds, and the serious losses so often associated with that disease, will be gratified at its successful control and will realise that its removal represents an enormous step towards a complete solution of the whole mastitis problem. In the meantime, the outcome of the efforts now being made to understand the nature of the corynebacterial, staphylococcal, *Str. dysgalactiae* and *Str. uberis* forms of bovine mastitis, and to work out methods for their control and treatment, are awaited with not a little impatience. Research workers and clinicians are already aware of the important part played by the milking technique in the spread of infection and the appearance of clinical mastitis. The work at Compton in connexion with the immunisation of goats against *Str. dysgalactiae* mastitis is of the greatest interest. It will readily be appreciated, however, that much will need to be done before effective vaccination against streptococcal mastitis becomes a practical proposition in the field.

Contagious abortion, which for countless generations has been responsible for staggering losses to cattle breeders in this and other countries, has now been rendered far less important by the widespread use of Strain 19 vaccine, due in large measure to the Calf Vaccination Scheme. The success of immunisation is abundantly clear, not only from general impressions gained in the field but also from carefully conducted surveys and the returns of artificial insemination centres. Nevertheless, every effort must be made to avoid complacency with consequent neglect of vaccination and recurrence of disastrous waves of contagious abortion. One can anticipate that the stage will be reached at which the use of Strain 19 vaccine renders it possible and practicable to eradicate this disease. The brevity of this paragraph, dealing with contagious abortion, must under no circumstances be regarded as a measure of the success achieved. In fact, it records one of the really outstanding accomplishments.

Removal of this infection of the reproductive tract from the list of animal disease scourges has had the effect of focusing attention on the high incidence of abortion not associated with *Brucella abortus*. During a five-year period, ending December 31st, 1955, 616 bovine foetuses were received at the Wellcome Veterinary Research Station. From only 46 (7.5 per cent.) of these was *Br. abortus* recovered.

The control of contagious abortion has done much to clarify the true role of *Vibrio fetus*. It is responsible for the abortion of a very large number of calves each year, but it is as a cause of bovine infertility that it assumes its greatest importance. As has been said so often, it is probably the chief factor contributing to the herd breeding problem in this country. Thanks to the efforts of workers in many countries, and especially to the painstaking observations made at Weybridge, genital vibriosis in cattle is well understood. Furthermore, workers at that centre have evolved an excellent diagnostic method, the vaginal mucus agglutination test, without which control measures would be difficult, if not impossible, to devise and apply. In addition, it has been shown at the Wellcome Veterinary Research Station that it is possible to treat vibro-infected bulls with complete success. It is now a practicable procedure to eradicate genital vibriosis from an infected herd. No doubt, in the not too distant future, this disease will be yet another which causes little trouble, thereby following in the footsteps of trichomoniasis, which is rarely encountered in this country to-day.

Foot-and-mouth disease has caused some concern since the war, particularly during 1952 when there were 495 outbreaks. However, thanks to the vigilance of our colleagues in the Animal Health Division, the position has been, and is, one for congratulation. Whilst, by present-day standards, a year in which there are 500 outbreaks is considered a bad year, it is well to remember that in 1871 there were more than 50,000 outbreaks. Interest in this disease has been stimulated, if any stimulation were necessary, by the publication of the Gowers Report, in which the slaughter policy is endorsed. On reflection it is quite remarkable how the farming community, in its wisdom, no longer criticises this policy. It is appropriate to refer here to the outstanding work of the Research Institute (Animal Virus Diseases) Pirbright, work which has given it an international reputation, second to none.

Few conditions result in such loss of flesh and interference with milk yield as does foul in the foot in cattle. This disease has now lost much of its old significance since the demonstration that it can be treated successfully with some of the sulpha drugs.

Both at Weybridge and Glasgow a great deal of work has been devoted to parasitic bronchopneumonia in cattle. These studies have not, so far, resulted in any satisfactory line of treatment, but have led to a far better understanding of the problem, and, again, this has been followed by improved methods for preventing this serious disease. The Glasgow observations on immunisation against husk are exciting and might well lead to an interesting and completely new approach to the problem. This whole study has drawn attention to certain non-parasitic types of respiratory disorders in calves.

Losses from liver fluke in cattle are not inconsiderable in some areas. With the risk associated with the use of carbon tetrachloride in the treatment of such animals, the introduction of hexachloroethane has marked a big step forward.

That heredity plays a major part in animal health will be accepted by all. It is, therefore, important to have a complete understanding of this subject and especially of undesirable genetical characters, if hereditary defects are to be avoided. Unfortunately,

in all too many instances, the genetical background for a disease has not been definitely established. Consequently, in the case of certain deviations from normal there has been, and still is, a great deal of speculation and controversy concerning the exact aetiology. The hereditary basis of bulldog calves in Dexter cattle has for long been established. Swedish workers showed that testicular and ovarian hypoplasia in Swedish cattle were due to an undesirable genetical character. More recently, workers in Scotland have presented evidence which establishes that oedematous calves in Ayrshire cattle are hereditary. Later still the British Friesian Herd Book Society publicly and to its credit recognised that certain Dutch imported bulls were capable of producing abnormal calves. The first conclusive evidence of a genetical type of bovine sterility in this country came from the Wellcome Veterinary Research Station, when a report appeared dealing with a sperm abnormality encountered in British Friesian bulls of a particular breeding. Claims have been put forward that cystic ovaries and adrenal virilism in cattle have a hereditary basis. Clinicians and others await with some impatience more reliable information concerning the contribution of heredity to other types of bovine infertility and to ketosis and bloat in ruminants. More and more evidence now being accumulated would appear to support the view that some undesirable genes are conditioned by environmental stress.

Reference must be made to the importance of progeny testing. It is encouraging that active steps are now being taken for progeny testing in cattle, pigs and poultry. Special mention should be made of the Relative Breeding Value, which has been evolved by the Milk Marketing Board in this country. This standard of breeding efficiency has several important advantages, the chief being its application to a large number of bulls in one year and the fact that the quality of the daughters is assessed on the farm and not in an unusual environment. With greater and greater demand for performance, this country cannot possibly maintain its position as the livestock farm of the world, unless due emphasis is placed on the importance of progeny testing.

Turning now to metabolic disorders, we are confronted with a record notable more for the amount of work which has been undertaken than for the progress actually made. Although there are no reliable figures to support such a view, it is generally believed that metabolic disorders among farm animals are to-day much commoner than they were before the last war. There is a great deal of circumstantial evidence to suggest that many of these diseases are related to a progressive farming policy and to a higher level of productivity. Nevertheless, we, as a profession, must acknowledge the importance to the nation of greater productivity. We cannot, therefore, countenance any retrogressive step. Let us then, whilst still accepting the possible relationship between higher productivity and certain metabolic disorders, strive for all we are worth to solve these problems without interfering adversely with high output—in fact, let us try materially to increase yields.

Milk fever has been known for very many years, and its successful treatment was worked out well before the period now being considered. Hypomagnesaemia reared its head more recently. In connexion with this problem we are indebted to the Weybridge workers for an exceedingly efficient method of prevention. In addition they, in collaboration with workers from the National Institute for Research in Dairying, have thrown some light on the factors contributing to the problem.

Acetonaemia was well known in the pre-war era, but during the war, and more especially since then, it has received much attention from research workers both in this country and abroad. We are greatly indebted to the Rowett Research Institute and other centres for a better understanding of rumenal digestion, one of the keys to some, at least, of the metabolic disorders encountered in cattle and sheep.

Hypocuprosis in sheep was recognised in this country some 16 years ago. Only in 1949 was its existence in cattle here first reported. Again, thanks largely to the efforts at Weybridge, we now know that this disease is widespread and leads to serious impairment of productivity. Fortunately, methods for its control and treatment are not only simple but are highly efficient.

A series of painstaking observations at the Hannah Dairy Research Institute has demonstrated the high incidence, the aetiology, and the importance of muscular dystrophy in calves of dairy and beef breeds. Here again it is fortunate that successful control measures have been devised.

Without good supporting evidence the view is held by many veterinarians and farmers that so-called physiological infertility in cattle occurs more frequently to-day than ever before. There has been a tremendous advance in the understanding of reproductive disorders. The better knowledge of the condition emphasises that there is no panacea for all types of infertility, nor is there any occasion to imagine that the employment of drugs, vaccines and hormones will be more than an adjuvant—and then only if intelligently applied—to success. Fundamentally, good results in this field depend on the skill and ability of the individual, based on the discriminating use of his experience. If only the veterinary surgeon in practice could have the opportunity to appreciate and to understand thoroughly the causes of disappointing fertility in his clients' herds! Much work has still to be done before this important problem is known in all its aspects. Even so, some worth-while level of success has attended the judicious use of hormone preparations together with attention to feeding.

During recent years a great deal of attention has been paid to the effect of industrial discharges on the health of farm animals. The extent to which fluorosis resulting from certain commercial undertakings influences adversely the health and productivity of livestock is only appreciated by those who have had experience of the problem. Unless appropriate steps are taken to modify the type of farming, the losses resulting from poisoning by fluorine can be ruinous.

Turning to management, we note that, during the last decade, there have been several revolutionary developments. Artificial insemination of cattle, started commercially in this country only during the war years, has made such rapid strides that to-day over half the dairy cattle in England and Wales are mated in this way. The widespread use of this breeding technique should lead to some grading-up of the national herd. It has, undoubtedly, done much to limit the spread of certain bull-borne infections such as trichomoniasis and genital vibriosis. The veterinary profession has reason to be proud of the part it has played in this spectacular achievement—a part which there is a tendency to forget in certain quarters. In the practical development of the method evolved by workers at the Medical Research Council for the low temperature storage of semen, veterinary surgeons have made a material contribution. The evolution of this new technique is undoubtedly one of the greatest feats of all time, in the field of animal breeding.

As far as grazing animals are concerned, as part of a general movement towards improved grassland management, we have witnessed a phenomenal increase in the use of the electric fence and, consequently, of strip and controlled grazing. This, together with attention to seeds mixtures and fertilisers, has done much to improve the quality and productivity of our pastures and, at the same time, to lead to a higher plane of nutrition for the grazing animal. On the other hand, through minimising the opportunity for selective grazing, it has tended to make the animal more dependent on the quality of the herbage presented.

Recent developments in the conservation of grass and forage crops have served to reduce the vitamin D status of the dairy cow when housed. Unless vitamin D supplements are provided, such an animal, during the winter months, relies for this vitamin on any storage achieved during the summer grazing period, and on sun-cured hay and straw. Unfortunately, dried grass and silage contain little or no vitamin D; consequently the feeding of these, to the complete or almost complete exclusion of hay can have a serious adverse effect on the vitamin D status of the animal, rendering it much more dependent on mineral intake and balance for the maintenance of satisfactory performance levels.

It would be true to say that, on the whole, the general standard of management and feeding of farm livestock is significantly higher than ever before. The decimation of the wild rabbit population by the myxomatosis virus has benefited particularly our cattle and sheep. The disappearance of the rabbit has not only improved the yields of cereal crops, and of crops intended for hay and silage, but has also improved the quantity and quality of grass available for the grazing animal—an improvement which is all too frequently overlooked.

Sheep

As far as the infectious diseases of sheep are concerned, many of these were already effectively controlled by the use of vaccines and sera well before the post-war era. However, marked improvements have since been made to these biological products, resulting in greater efficiency and ease of administration.

The Diseases of Animals (Therapeutic Substances) Order, 1952, came into operation at the beginning of 1954. By prohibiting the manufacture and importation for sale, except under licence, of vaccines and sera, and by prescribing the standard of safety applicable to them and tests for determining whether that standard has been attained, this Order should ensure greater confidence in these biological products. This, as all will agree, is definitely a step in the right direction.

Thanks to the efforts of workers at the Animal Diseases Research Association Institute at Moredun, the cause of enzootic abortion in ewes has been elucidated, and to that achievement has now been added a highly successful method of immunisation against this disease. There are other, as yet imperfectly understood, causes of ovine abortion.

The position with regard to scrapie is little better now than it was before the last war, although the disease is better understood.

The problem of Johne's disease in sheep is one which is appreciated. In certain circumstances the losses which it occasions are not inconsiderable.

The earlier work in Australia, and more recent investigations in this country in connection with foot-rot in sheep have emphasised the contagious nature of this disease. The fact that the causal organism lives only for a short time on contaminated pasture has resulted in effective control measures being devised. In view of the enormous total losses resulting from foot-rot, these measures can confer inestimable benefits on flockmasters and are, therefore, worthy of serious consideration in all areas where sheep contribute to the agricultural economy.

Success during the last 10 years in combating so many of the important infectious diseases has been at least equalled by the efforts of those primarily interested in infestations with both internal and external parasites. Amongst farm animals the greatest loss due to internal parasites is associated with parasitic gastro-enteritis in ruminants. During the war the use of phenothiazine proved a great boon. This anthelmintic is still the cheapest and most efficient available for treating gastro-enteritis in cattle and sheep. To deal with some species of sheep worm, other than *Haemonchus contortus*, it would appear that the dose should be at least twice that originally recommended. Even at greatly increased dose rates some intestinal helminths are not affected by phenothiazine. This applies particularly to *Nematodirus fillicollis*. Outbreaks of nematodiriasis have caused serious losses in lamb flocks in various parts of the United Kingdom during recent years. A satisfactory line of treatment is awaited. In the case of parasitic gastro-enteritis, as in other forms of internal parasitism, a better understanding of host-parasite relationship has resulted in the development of efficient and practical control measures.

Reports are still received of quite serious losses in sheep resulting from liver fluke. It is doubtful if, on

the grounds of cost and efficiency, any drug discovered so far is superior to carbon tetrachloride for the treatment of fascioliasis. In dealing with this disease, the important part played by the intermediate host of the parasite must not be overlooked.

Turning to external parasites, it is again possible to record outstanding successes on the part of research workers, resulting in the presentation of products of exceedingly high efficiency. This story starts with the wartime introduction of DDT, followed by benzene hexachloride. The persistence and long action of the latter has been a major factor leading to the eradication of sheep scab in this country. When the heartbreaking struggles, which went on year after year, particularly in hill farming areas, are remembered, the total elimination of this disease seems too good to be true. Certainly this is one of the major successes of the post-war era.

Great strides have also been made in tackling flies and ticks. Newer dips, particularly those containing dieldrin with its protective period of 10 to 14 weeks, mean that one dipping can cover the complete fly season. In some parts of the world a great deal of trouble has resulted from the development of strains of both flies and ticks which are resistant to the newer dips. Fortunately, as far as is known, these drug-resistant strains of ordinarily sensitive ectoparasites have not, as yet, been encountered in the United Kingdom.

Of the metabolic disorders of sheep, pregnancy toxaemia is still a serious problem, the elucidation of which calls for further efforts on the part of the biochemists, although practical feeding methods have been shown to be of real value in reducing its incidence.

Pigs

The pig farmer has good reason for being grateful to veterinary research workers and clinicians. Thanks are due to the Weybridge team for their work on swine fever crystal violet vaccine. This prophylactic, together with sound legislation, is responsible for this country's comparative freedom from swine fever to-day. Due credit must be given to those responsible for the Swine Fever Registered Vaccinated Herds Scheme. It is perhaps salutary to reflect that during the year ending December 31st, 1940, there were 5,019 outbreaks of swine fever in the United Kingdom; during the year ending December 31st, 1955, there were only 1,403 outbreaks.

Reference must be made to the work at Cambridge on virus pneumonia in pigs. The painstaking researches at that centre have provided ways and means of controlling a disease which causes enormous financial loss to the pig industry. As so often happens, this work has served to focus attention on the multiplicity of factors contributing to respiratory disorders.

Atrophic rhinitis in pigs was an alarming proposition but, thanks again to the Weybridge effort, this disease can now be viewed in its true perspective. Although it is not a condition to be accepted lightly it is, nevertheless, one which, with reasonable precautions, should not lead to serious losses.

Some surprise might well be occasioned by the inclusion of antibiotic supplements at this point. It is true that, originally, the beneficial effects of these supplements were, by some, attributed to certain specific growth-promoting substances which they provided; the animal protein factor and vitamin B_{12} were suggested. However, there is now a strong body of opinion that the antibiotics included in rations fed to horses, cattle, pigs and poultry do not supply any such specific growth-stimulating elements. Rather is it thought that these antibiotics lead to increased growth rate through merely acting in the role of bacteriostatics, thereby limiting the activity of deleterious micro-organisms. The continuous feeding of these supplements would, in some instances at least, appear to have a prophylactic effect rendering the recipients relatively resistant to certain infections.

At the beginning of this period, ascariasis in horses, pigs and poultry was being controlled and treated with some degree of success. Of the therapeutic measures the most efficient was that involving the use of sodium fluoride for pigs. The more heroic also used this drug for foals. However, whilst exceedingly cheap and effective, it was somewhat dangerous even in the pig, with the result that a number of unfortunate accidents occurred. The introduction of piperazine salts has provided the clinician with a weapon which is both highly efficient and very safe. Moreover, piperazine can be used for the treatment of horses and poultry as well as pigs.

For a number of years stallion and bull licensing have been part of the agricultural story. It is only during the post-war era, however, that boar licensing has made its full impact on the pig industry. There is no doubt that this scheme has already led to a marked improvement in pigs now being bred on mixed farms as well as on those specialising in this species.

During much of the last decade, oedema disease has been a troublesome problem in the field and has occupied a great deal of the time of some research workers. Unfortunately, the disease is as yet imperfectly understood.

Commercial artificial insemination of pigs is now in operation, and future trends are awaited with the greatest possible interest.

During the past 10 years much progress has been made in providing more suitable accommodation for farm animals, especially for pigs. It is now fully realised that housing has an extremely important bearing on the health and productivity of these animals.

Poultry

In the poultry field, in spite of much effort on the part of legislators, of the field staff of the Animal Health Division and of research workers, particularly at Weybridge, Lasswade and the Houghton Poultry Research Station, the position is, on balance, not equally rosy. Fowl pest is still exceedingly troublesome (the advent of the sub-acute form of the disease has rather tended to increase the difficulties associated with diagnosis), leading both to direct and indirect loss to poultry farmers. The necessary restrictions on transport of poultry result in a great deal of financial

loss for some sections of the industry. However, these restrictions, together with the provisions of the Poultry Markets and Receptacles (Disinfection) Order, must limit the spread of this serious disease.

At the beginning of the period under review, it was shown that sulphonamides could be used for the control and treatment of caecal coccidiosis in poultry. Since then rapid strides have been made and, as was only to be expected, some difficulties have been encountered. These have been chiefly associated with treatment interfering with immunity response, and also with the toxicity of the drugs employed. The former can, to a large extent, be avoided by making use of information now available in connexion with the host-parasite relationship. The danger of toxicity might well be overcome as the result of observations made at Weybridge. These open up great new possibilities for the control and treatment of coccidiosis. Following a report from the United States, it was shown that there existed a very marked synergistic action between certain sulphonamides and a pyrimidine. This potentiation of one drug by another is probably due to the fact that each interferes at a different point in the same metabolic pathway of the parasite. The sulphonamide affects the utilisation of *p*-aminobenzoic acid, and the pyrimidine disturbs the folic-folinic acid sequence. Consequently, the two drugs given together are exceedingly efficient when both are provided in very small doses—doses well below the toxic levels.

Various salmonella infections of poultry have received attention during the post-war era, and real progress has been made as far as bacillary white diarrhoea is concerned. This results largely from the introduction of the Accredited Poultry Breeding Stations Scheme. Shortly after the war the presence of exotic salmonella infections in flocks of poultry was attributed, in part at least, to the importation of large quantities of dried egg. These particular infections appear to cause relatively little concern at the present time.

Leucosis still remains a major disease problem in the poultry field. Unfortunately, no spectacular progress can be reported by those research workers paying special attention to this complex, although much additional information is now available.

Respiratory infections, as they occur in this country, continue to result in appreciable losses, but these are not comparable with those sustained by overseas poultry farmers, particularly in the States.

So far as poultry is concerned, in the field of management the most noticeable change has been the swing to the deep litter and poultry yard systems—systems which have proved successful not only for egg production but also for the continued maintenance of health. The latter, at first sight, appears to be quite contrary to earlier views on the avoidance of parasitic and other infections. Needless to say, these systems call for a very high level of skill and vigilance on the part of those who adopt them. Any failure to attend to detail can lead to catastrophic disease losses.

Conclusion

Unfortunately, for very obvious reasons, I have been able in this paper to deal with only some of the facets of farm health. Time does not allow of reference to such important and interesting problems as diseases of calves, lead poisoning in cattle, black disease in sheep and fowl typhoid. It is to be regretted that, through lack of superlatives, it has not been possible to emphasise adequately all that has been achieved. Again, as mentioned earlier, the decision to give no detailed references just had to be taken, so great was the field to be covered.

It will, however, be readily agreed that my earlier optimism has been justified. In spite of views expressed to the contrary, the health of farm livestock in Britain is better to-day than ever it has been. It is so easy to magnify the importance of those diseases which are not well understood, and for which efficient measures for control and treatment are not available. At such times it is salutary to reflect for a minute on those diseases which have been eradicated, or for which good prophylactic and therapeutic measures are already to hand. Many members of the profession have had no opporunity to realise the extent to which certain diseases, *e.g.* tuberculosis and contagious abortion, were, at one time, a nightmare to the owner and his professional adviser. They can hardly be expected to appreciate the advance which has been made. The present satisfactory position is largely due to the efforts of all branches of the veterinary profession and to our collaborators in associated fields of science.

The major role played by the Animal Health Division should receive special mention. The present happy situation is in no small measure due to the efforts of those who staff that Division in its variety of activities. The benefits derived from restriction on the importation of animals and animal products, from control of movement, and from compulsory boiling of swill, for combating such problems as foot-and-mouth disease, swine fever and fowl pest are worthy of special emphasis. Despite all the inconvenience attendant on such measures they have contributed much to the present exceedingly favourable position.

Finally, this Association can take credit for the part played by its Survey, and more recently, its Technical Development Committee in contributing to the post-war successes.

Summary

A short review of the general farm health position during the post-war era is presented.

Consideration is given to certain infections, parasitic diseases, hereditary defects and metabolic disorders of cattle, sheep, pigs and poultry. Attention is also paid to the importance of management.

Reference is made to progeny testing.

The important part played by the Animal Health Division in the present satisfactory state of farm health is acknowledged.

THE SPEAKER'S INTRODUCTION

Mr. S. L. Hignett, in introducing his paper, said: "At the outset I wish to thank the Association for the signal honour it has conferred on me in its invitation to be the first speaker at this important session. My paper having been circulated, I take it that it has been read, by a few at least, of those present this morning. Suffice it then for me to introduce my contribution as briefly as possible.

"Until I got down to hard and fast facts, so essential for producing a paper of this type, I was rather inclined to think that my views on the achievements of the veterinary profession were perhaps somewhat biased. However, the collection of necessary data proved to be most stimulating and certainly most encouraging. I am now prepared to state quite categorically that the successes which have met the efforts of workers in veterinary science, and in allied fields of endeavour, have been simply outstanding during a period of nearly 100 years; but at no time has the progress equalled that which can be recorded for the post-war era. Fortunately for me, the invitation to give this paper not only provided the title, but also indicated that I was expected to cover the period which has elapsed since the cessation of hostilities in 1945.

"I suppose some of the animal disease problems with which I have dealt actually chose themselves. I refer to such diseases as tuberculosis, contagious abortion and foot-and-mouth disease. On the other hand, problems of secondary importance were so numerous that it became completely impossible to cover them all. In fact, it would be quite easy to produce another paper just as long as this with a completely new set of such diseases under consideration. Special attention could be paid to anthrax, swine erysipelas, veterinary paediatrics, bloat, duck virus hepatitis and, to be even more topical, mucosal disease. I have made no reference to plant poisoning; recent publications have brought home to us the losses which can result from the ingestion of bracken, ragwort and acorns by farm live-stock. I should like to emphasise that the omission of so many animal disease problems does not mean that I have selected only those in which real progress has been made. The success story applies to many of the omissions. It is a matter for regret that space did not allow inclusion of advances in farm animal anaesthesia and surgery.

"Let us not forget that several important trends in agricultural methods have tended to aggravate such problems as parasitic gastro-enteritis and parasitic broncho-pneumonia. Consequently, progress in our fight against these is even greater than appears at first sight. It is, of course, so easy to forget our successes, particularly when we are concerned with some new problem, or struggling with an old one which is temporarily assuming greater significance.

"Not unexpectedly, I have been called to task by Dr. Russell Greig for my failure to include the working dog as a farm animal. Of course, he is quite right. By way of making amends, I have obtained permission to quote from his letter:—

"He says, 'What about the dog as a farm animal? The sheep-dog is the key animal to the whole of the sheep industry. One of the diseases to which his irrational feeding exposes him is black tongue which yields so spectacularly to nicotinic acid (discovered 1937).

"'I have found that flockmasters and shepherds are woefully ignorant of this and do not call in veterinary assistance whereby many a good dog would be saved. A wide publicity for this simple fact would be of great service.'

"On re-reading my paper, I feel I may have given the wrong impression regarding the achievements of those who have specialised in poultry research. Some extraordinary good work has been done in this field, work which is deserving of the highest praise. In the paper I merely wish to indicate that much more financial support must be forthcoming for poultry investigations. This branch of agriculture has now assumed great economic importance; furthermore, the intensive systems of poultry husbandry so widely employed at the present time, do tend to favour the spread of disease and therefore increase the difficulties of those grappling with the problem of poultry losses. In connexion with fowl pest, reference should now be made to the Poultry Premises and Vehicles (Disinfection) Order 1956.

"In this introduction I must, once again, refer to our indebtedness to the various sections of the Animal Health Division. It was when my data were collected and viewed quite objectively that the outstanding leadership given to the profession by the Animal Health Division became crystal clear.

"The rôle of practising veterinary surgeons must not be forgotten. In no small measure the present satisfactory farm health position is due to their unceasing struggle. This band of workers is still the backbone of the profession and must at all times be called upon to make its exceedingly important contribution, if the health of farm live-stock is to be still further improved and maintained.

"We all appreciate that much remains to be done. The metabolic disorders and, as already mentioned, some poultry diseases are a real challenge. To make full use of the accumulated skill and experience of veterinary surgeons, we require better and better diagnostic facilities and methods, and better procedures and materials for controlling and treating animal diseases.

"In spite of my many omissions, some of which no doubt will be covered by Sir James, I sincerely hope that my contribution will stimulate a lively discussion."

The Opener

Sir James Scott Watson (Editor of The Agricultural Review of *The Farmer's Weekly*): "I do not complain in the least that you should have asked me to open this discussion; indeed, I welcome the opportunity of expressing my own admiration and the gratitude of the whole farming community for the services which you have rendered already, and that you are still rendering, to the farming industry. I think it probably takes someone like myself to measure up the benefits which that industry has received at your hands.

"My own memories of live-stock go back 60 years; indeed, I think it must be 60 years almost to the day since I was first armed with a big stick and put out into a field with orders to chase the cattle through the gate into another field at the first sign of any departure from a bilateral symmetry. I come from a long line of farmers who, through the years, have suffered immensely—but decreasingly—from animal diseases. My grandfather started in the autumn of 1865 with something over 60 head of cattle and ended, the next spring, with one old cow; she had not caught the rinderpest because she was kept in a shed in an outlying field and did not get infected. There was a neighbour who was even harder dealt with; he had one of the leading herds of pedigree Aberdeen-Angus cattle which was completely wiped out. Having collected the nucleus of a new herd, it fell a victim to the second rinderpest epidemic. My grandfather used to regard foot-and-mouth disease as just 'one of those things.' I think he was rather glad when it turned up in the autumn, because he was a winter feeder; if the cattle were lean when they got the trouble, they were a bit leaner when they recovered, but he was still able to fatten them, more or less, by the following spring; whereas, of course, on the two or three occasions when it struck him in March when his cattle were nearly fat, he had to start the feeding process all over again.

"There were many family traditions about broncho-pneumonia and the incidence of 'piners' among cattle. Among my recollections is one of a Jersey house-cow which took milk fever on three successive occasions. In the first two she responded to (or at least survived) the traditional treatment, which was two bottles of 'Scotch'; but even 'Scotch' did not save her the third time and she died. I remember the astonishment with which I first saw a cow's udder inflated, and later the miraculous effect of an injection to restore the calcium status of the blood.

"Within my own farming experience, with university and college farms, I have had my struggles with piglet anaemia. We started a herd on the indoor system. The treatment with iron solution had only just been developed, otherwise the outbreak would have been disastrous.

"From my early days I remember a lot about liver rot in sheep. I remember being at Perth when an Irishman of my acquaintance was buying in-lamb ewes. I asked if this was his usual practice; he said 'No, I bought 150 in

the autumn and more than 100 have died with liver rot; I am only replacing my casualties.' The destruction of good cattle with mastitis was another unhappy experience.

"Having watched with admiration the progress of veterinary science, I would say that the most striking thing has been a change in the whole approach to animal health problems. When I was a boy we had the 'vet.' for a lame horse or a difficult calving; I remember bicycling 4 miles to get him when anything went wrong; but the approach was the treatment of the individual animal. Of course, the individual sheep was not worth the expense of the veterinary surgeon's fee, and the only remedy for the sick sheep or lamb was to cut its throat. We have seen a new approach through preventive medicine and a drive for 'positive health,' The whole situation has changed dramatically.

"I remember how, in the early 30's my own veterinary practitioner in Oxford stood in great fear of underemployment. Like many others, he depended very largely on his horse practice both in town and in country; he saw that the days of the horse were numbered; and he failed to foresee the developments which were to come. I remember, too, having a chat with a friend who was in the Scottish Department of Agriculture and was responsible for education and research. He talked about the proposals which were being mooted to close down the Glasgow College. Student numbers were very small, the College was extremely poor, there were only two or three people on the permanent staff, all the others being in private practice. It seemed that the College was really down. We have heard about the position to-day and the facilities needed to provide the required numbers of trained research workers and practitioners.

"I want to talk to you mainly about some of the secondary benefits arising out of the degree of animal health control which has now been achieved. One example is the tremendous help to the improver of live-stock. I knew, very well, a farmer who had an ordinary useful herd of dairy Shorthorns. He was anxious to do various things; he wanted to have a pedigree herd, he wanted to record and to improve his milk yields, so that ultimately he might sell bulls. He had so many diseases—beside TB. reactors—that he remarked in the middle of his campaign that he was getting nowhere, either with the improvement of the cattle or anything else. He had three empty stalls waiting for every heifer to calve down, and he did not want to go to market and buy cattle. At the end of a long life he had succeeded; had got his herd attested and in the Herd Book. He had raised his milk yield from 650 to 800 gallons, but this had taken practically the whole of his working life. We are now very much better off. The reduction in wastage by disease has given tremendously increased scope for the genetical development and improvement on which the efficiency of our live-stock depends.

"There are other developments in agriculture which are making your job more difficult. One of them is the degree of specialisation in live-stock enterprise. In the old typical farm there were cattle, sheep, pigs, poultry, all in some sort of balanced proportion. If one reads the old husbandry books, one realises that this was the normal thing—a mixed farm with a mixture of live-stock. The development of specialised poultry, pig and dairy farming has increased the hazards of disease. Again there is the progressive intensification of our methods of live-stock husbandry. We are going for ever higher intensification of pasture management, and the more stock we carry on a given acreage, the greater must be the disease hazard.

"Whether there is anything directly inimical to health in some of our modern methods—heavy nitrogen fertilisation and so forth—I do not know; but the combination of the heavy use of fertilisers, more productive types of plant and new systems of grazing must combine to increase disease risks.

"Next, there is the specialisation of function; for example, most cattle were at one time more or less 'dual-purpose'; specialised dairy breeds were the exception rather than the rule. We have specialised cows for milk; we have specialised fowls for egg production; we have bred pigs to increase the average litter size, from the four which is typical of the wild sow, to something between nine and ten, and we regard 12 as a desirable number. I suppose when breeders reach 12, they will want 14. Again, we want to finish our beef cattle at 18 months or two years of age instead of being content to keep them to three and a half or four years.

"I do not think these developments in agriculture are necessarily inimical to high standards of health. Indeed, I believe, for instance, that the change to leys as a substitute for permanent grass has potentialities in the way of health improvement. I was brought up in a ley-farming country; there was no permanent grass on my father's farm except 10 acres which could not be ploughed. The whole of the rest was rotational grass. I believe it is true that alternate husbandry is helpful in the control of sheep parasites and cattle parasites and possibly of Johne's disease. It is a fact that I never saw a case of Johne's disease either on our own farm or any of our neighbours, which were run on the same lines. It was only when I moved to Oxford that I became personally acquainted with Johne's disease. I had hardy been on the University farm a month before I saw a heifer looking very seedy. I told the cowman to put her in an isolation box and he said, 'She will make the sixth and she will go the way of the rest to the knacker.' Here the pastures were all permanent.

"I could not help thinking yesterday that the relative freedom from parasitic and other pasture-borne diseases of my home area must have something to do with the system of grazing. We made a point of running our calves on new leys during spring and changing them, at midsummer, to hay aftermaths.

"May I repeat what I said at the beginning? I think I am expressing the admiration and the gratitude of the whole farming community for all that you have accomplished; and I, and the farming community as a whole, wish you every success in your further labours."

The General Discussion

Mr. K. D. Downham (Cirencester) said that Sir James Scott Watson had given a very interesting introduction to Mr. Hignett's extremely interesting paper but he felt that as one who had had the opportunity of working for a good many years on some of the developments which had taken place that he should be more critical of present-day trends. He, Mr. Downham, had an uncle who was a very big practitioner who had in his surgery a painting of a bulldog and underneath were the words, "If anyone wants to know who is the boss here, start something." He would like to start a lot of things; he would begin by criticising the Animal Health Branch of the Ministry of Agriculture for some of the things which had not been continued and which had been started and were being carried out not very long after he qualified and which were not being done on anything like the same scale now. He wanted to be critical not only of his own profession but of agriculture.

He had an interesting job when at Liverpool to try to stimulate agriculture to do something about tuberculosis in cattle, and it was common for him to take monthly samples of milk from one herd and regularly to find tubercle bacilli in the milk which was sold unboiled for human consumption. He talked to an eminent agriculturist about T.T. who said, "Do not say anything about it, you will put people off buying milk!"

Not nearly as many milk samples were examined now for the presence of tubercle from some country districts as were examined some years ago. He remembered talking to an ex-Chief Veterinary Officer shortly after the loss of the county veterinary services and telling him that from his experience of several counties in the Midlands the Ministry of Agriculture were not doing their job as well as it had been done, and in some ways this was the case to-day. A great opportunity was lost when the county veterinary service, worked and run by practitioners in close co-operation with whole-time veterinary men serving the various bodies concerned, was closed down. That team had gone. There was a tendency these days for bureaucratic control and he thought this was very bad, they should be able to go with the medical service on to the farm to see what was happening. At present that could not be done so well with the service which had been offered as a National Agricultural Advisory Service because they were all under this one bureaucratic type of control. He was not trying to be

political but they did suffer very greatly from the lack of the individual touch with agriculture.

The profession had lost a great deal by not taking its rightful place in the control and design of animal buildings, it should be in the same position as the medical health service and be in control of all animal buildings in close touch with the other professions and the architects. Some of them were first-class but he did not think any of them could do their job as well as they would if they had had a veterinary training.

There had been great improvements but animal husbandry was so linked with health and nutrition as well as genetics that there should be a much closer control in the education and development of people who were to advise on the development of live-stock in the greatest live-stock producing country in the world. Enormous strides had been taken. Mr. Hignett had told of a large number of progressive changes but the right people should be doing the right things and the best person to take the lead in animal health development and production in close co-operation with the agriculturists and the medical profession was the veterinary surgeon.

It was from the Royal Agricultural College that the first veterinary man who tried to control serious animal scourges came and started an animal health service, and he wondered what the late Sir George Brown would have said if he knew of some recent missed opportunities. He himself had the privilege of working there with a man who had been for 50 years at the college and was one of the wisest and most knowledgeable men he knew, Major Duncan, F.R.C.V.S., who certainly had seen many changs. The profession must be much more critical; must go into the question of water supplies, for instance. Johne's disease was an eye-opener in this respect, and the importance of nutrition was fundamental, yet sometimes we went chasing after the odd bacteria or strain of bacteria and missed some of the fundamentals regarding positive health.

Ours was a small profession, we had not some of the advantages of the larger medical and agricultural organisations, but it seemed to him absolutely essential that they should stop praising themselves and saying how good they were and do something positive in the way of better animal buildings, meat inspection, fundamental research, nutrition and water supplies for farm animals in this country.

Mr. J. Deans Rankin (Compton), said that to-day he would like to praise the Animal Health Division instead of criticising it. On reading through Mr. Hignett's paper, one felt very proud of oneself. The paper was full of superlatives. Phrases like "nothing short of miraculous," "enormous step forward," "really outstanding accomplishments," "an international reputation, second to none," etc., kept cropping up. One became so blown up with pride that the application of a pin seemed indicated. The necessary pin was to be found in the paper itself—even if slightly disguised. There were other phrases such as "perhaps as great now as ever," "Although there are no reliable figures to support such a view," "without good supporting evidence." Notice the uncertainty.

The great weakness of the profession to-day was that its members did not know of the existence, or relative economic importance, of half the diseases of animals in this country and, as they were organised at present he did not see how they were ever going to get that information. They were like the advance post in an army, they were supposed to know not only where the enemy was and what he was doing now, but also what he was likely to do to-morrow. It was time they got themselves into the position where disease trends in this country could be followed. The only way this could be done was to bring abattoirs and knackeries under the supervision of the Animal Health Division. The Division was pressed by succeeding Governments to investigate this or that disease, yet, while Royal Commissions praised it, these Governments persistently withheld this very necessary weapon of its offensive and defensive armament.

Mr. T. Barton Mann (Weyhill) said that he had studied this paper for some time prior to this meeting; it was evident that Mr. Hignett had investigated these troubles in a very thorough manner. It seemed to him that the investigation had proceeded along the lines of a purely veterinary approach to the subject and he was inclined to agree with Mr. Downham that it was time a proper view of these diseases was taken.

His specialist activities were with turkeys; he was in charge of a plant which had a turnover this year of about £270,000, which had produced nearly 500,000 poults for distribution throughout the country and which, at the present time, was using between 140 and 150 tons of food a week. He had formed the opinion, rightly or wrongly, that he knew something of the diseases of poultry. There had been no salmonellosis in the stock this season, coccidiosis and blackhead had ceased to be an anxiety except under certain circumstances which he would mention presently, and, by and large, they had managed to pay the wages of over 100 people, spend money on research and make the business pay.

He was bound to agree with the speaker, who said that the veterinary profession must look to itself more closely; in this connexion there were two aspects he could suggest. First, there was a danger that the profession would play into the hands of the animal feeding-stuffs' manufacturer; second, that scanty attention was being paid to grassland management and the impact of grass nutrition on diseases of stock.

For feeding-stuffs; he could only cite the experience gained this year when his business had stepped up the numbers of breeding stock from 10,000 to 15,000. The food mill installed and designed to make foods for 10,000 breeders and their progeny had been unable to cope with the increase, and the various farm managers had turned to proprietary foods in order to rear the excess production. The practice was to rear in units of about 60 baby poults, by a well-tried system, to eight weeks of age.

The net result of this experience was that of 60 poults reared on proprietary foods only 48 could be classed as saleable birds at eight weeks with a further four attaining the desired weight and appearance by nine weeks. There was an uneconomic residue of eight or less, depending on losses, at the end of this period. On foods of their own manufacture and in an adjoining part of the plant, with the same attendants and similar management, of each 60 poults started, 56 made the grade at seven weeks, the remaining four by eight weeks; losses were negligible. He certainly had had abundant opportunity to study disease and the after effects of wrongful nutrition in the unthriftiness of those poults left over after feeding proprietary foods. This had been an actual and factual experience in the use of nearly 280 tons of purchased foods. Because of it, he suggested that the profession would have to do a lot of hard thinking on the impact of nutrition on these common diseases of poultry and that the individual veterinarian should avoid being misled by the fascinating, but glossy, propaganda of the food manufacturers.

With regard to grass and grassland management, he well remembered a day in August, 1937, when he stood in a field in Leicestershire listening to Sir James Scott Watson discussing this problem with representatives of 39 countries and, at the conclusion of the proceedings, many of them crawling about the pasture, botanising and classifying the types and species of grasses and clovers in an endeavour to discover the secrets of a "fattening" pasture. He would have liked to have heard Sir James, a recognised expert in these matters, say something about this aspect of farming and possibly connected with the business in hand, the impact of grass and grassland management on stock yields and stock troubles. What had happened to the promise of the Cahn Hill Improvement Scheme where, by ploughing Welsh hill pastures and re-seeding with Aberystwith strains, seven ewes and five lambs were to be produced on one acre which hitherto had carried one ewe and two lambs at the height of natural indigenous grass growth?

Had it ever been demonstrated that the production of new strains of grasses and clovers, the rapid growing and high leafy sorts, had not led to more and more disease in stock because of their higher protein and, at certain times of the year, high fibre content? His researches tended to show that the availability of nutrients of some pedigree grasses was poor. For example, the deposition of carotene, xanthophyll and vitamin A in the breeding egg was poor from a pasture of S23, a pedigree, leafy perennial ryegrass strain, whereas it was excellent from a pasture of *Poa annua*,

an annual meadow grass, the seeds of which were cleaned out of pasture seeds' mixtures, as an undesirable weed. His experience, over many years, was that S23 or, for that matter, any other perennial ryegrass, was death and damnation to poultry. The ryegrasses, besides having a low availability of nutrients, were positively disliked by poultry; stock would go out of its way to avoid them, would glean through the pasture to find other grasses, and, if finally, having eaten everything else, was forced to eat ryegrass, would end up impacted or debilitated, a prey to all and every disease in the text-book.

It had been suggested that more and more money should be allocated for research into the problems of disease. He was in close touch with the poultry industry; many breeders and producers had intimated to him that they were loath to donate money to the type of research which was at present proceeding. This seemed to be along the lines that drugging was the answer to disease. He knew of farmers who were spending as much as 5s. per bird on this, that, and the other drug recommended by the profession as the answer to their troubles, and this at a time when turkeys were fetching less than 2s. a pound. They found they simply could not go on with the venture and cancelled their orders. On the farms of his organisation they had recourse to drugs only when the tenets of nutrition had been violated and as a result of this violation, latent disease tended to fulminate. Happily, by having close veterinary control, this happened only on rare occasions and the cost of drugs or medicaments became an infinitesimal part of the cost of production.

Dr. R. F. Montgomerie (Wellcome Research Laboratories) said that the meeting must have been interested in Sir James Scott Watson's reminiscences which were designed to prove or support the superlatives which Mr. Hignett used in the paper and of which Mr. Rankin seemed to complain. He was going to support the use of these superlatives because he was just old enough to take a fairly long view of the past and yet not imagine that everything in the past was good. He thought the superlatives in the paper were justified, and the tributes which had been paid were perfectly just. In other words, the progress which had been made in this country was truly phenomenal or remarkable, whichever word one cared to use, but that progress had been made against a background of prosperous agriculture. It was most important to realise that. It seemed to him they were almost in a vicious circle. If there was a reasonably prosperous agriculture a chance was given to the veterinary profession to do investigational work on the farm, and to really do a thoroughly good job. Agriculture was therefore made more prosperous and they had greater opportunities, but the basic point, surely, was that they started off with a prosperous agriculture. He thought that this point had not been sufficiently emphasised by Mr. Hignett in his paper and by some speakers.

He would like to preach perhaps directly to the Minister himself and to those who settle policy in the agricultural world and he knew that although Sir James might be retired his influence still existed. He would wish to preach that the basic principle in this country of keeping a prosperous agriculture gave the opportunity for progress in farm health. The work which had been done had made agriculture more prosperous and he hoped that the vicious circle would be continued.

The second point which he wanted to make was that undoubtedly there had been remarkable changes in agriculture, in methods of management and all the rest, but there had been occasions when these changes had not been appreciated by the profession sufficiently early to meet what might, in some cases, have arisen. Yesterday there was a question whether strip grazing was a great danger to Johne's disease. Some of them might have appreciated the coming of that change and got straight down to work to make certain that they knew the answer to such a change. The point which Mr. Rankin had covered was one which came out clearly in Mr. Hignett's paper. This was that until there were better methods of surveying the incidence of disease in this country so long would they have a poor starting point for much of their work.

Mr. Rankin made a plea that slaughter-houses and knackers should come under the control of the profession to assist in one of their primary objectives of getting a knowledge of what was happening in the disease field. All knew of the efforts of the British Veterinary Association to get a better picture of the incidence of disease in this country. He hoped someone would take up that point and let them know the road along which the Association had progressed so far in the matter. He thought there was a good deal of sympathy for that view.

He would like, if it was not out of place, to make a plea that some time during this meeting there should be some fairly clear indication of the progress which the Association had made towards having a better survey of the incidence of animal diseases in this country.

Miss Olga Uvarov (Cobham) wished to correct Mr. Hignett in that she had, in fact, read his paper twice. On the first reading, the impression was not favourable—the paper was too broad, it had no bibliography, some conclusions were too impersonal, etc., but because the paper was written by Mr. Hignett and all publications from the Wellcome Foundation are always informative, the paper was re-read. One then appreciated the broad outlines on which the paper was written, and it was evident that it was so presented as to give plenty of scope for discussions, particularly by practising veterinary surgeons who could give their findings on incidence of disease in their area.

Mr. Hignett, at any rate, in speaking about some diseases, had revealed one of the weaknesses in reviewing health problems in animals, in that incidence of disease was often lacking. Neither did he commit himself to specify changes in disease pattern or incidence, one of such examples being mastitis. This disease was of great concern to all, both from the epidemiological as well as economic point of view. The author indicated the change of bacterial flora in that disease, but avoided stating its present incidence. It would be interesting to get Mr. Hignett's own opinion on this, as well as on the loss of milk and the cost of mastitis to the country. A certain sum had been quoted for some years, but it was quite likely that it was now out of date.

In discussing *Vibrio fetus* infection, Mr. Hignett had pointed out that it is now possible to treat this infection in bulls. This has also been confirmed by several workers of the Ministry of Agriculture at the Third International Congress on Animal Reproduction, Cambridge, June, 1956. This will be reported in the proceedings of that Congress, and when these are published should be valuable information to practising veterinary surgeons who were unable to attend the Congress.

Miss Uvarov asked Mr. Hignett to elaborate if possible on the subject of antibiotic supplements in pig feeding. He rather covered himself by saying that "A strong body of opinion" considered that the action of antibiotics in feeding was in the nature of bacteriostatics. Would he enlarge or comment on the work done on the use of inactivated penicillin in pig feeding, and the results achieved and was it not generalising too much in describing only this action of antibiotics in feedingstuffs, and what of the theory that some stimulation of the pituitary gland occurs during the use of antibiotics in feeding, leading to increased production of growth hormone and increased growth?

Mr. Hignett said in his introduction that one could write yet another paper, she quite agreed; he wisely left out several conditions which veterinary surgeons in practice had to deal with, and she would suggest to the Organising Committee that one subject that could be discussed at some other conference would be the importance of scours.

Some speakers had criticised some of the work done in the past. Was it not better to look to the present, or better still to the future, and tackle the question of knowing more about incidence of disease. At present the chief source of information on this could only be found in the Annual Report on the Animal Health Services. This generally takes quite a long time to appear. She did support Dr. Montgomerie's statement, and did suggest that some way should be found for collecting more information on the pattern and incidence of disease.

Professor D. L. Hughes (Liverpool) said that he was interested and relieved to listen to Dr. Montgomerie and Miss Uvarov because he felt that there was a possibility that there was no escape from the atmosphere of inspissated gloom with which they started off. It was unfair to criticise Mr. Hignett's optimistic paper, he was one of those

refreshing people who could always find something to be cheerful about.

He was very interested in Mr. Hignett's reference to certain problems which were arising of a genetical character. He mentioned dropsical calves and the classical bulldog Dexter cattle. He thought he was right to pay a compliment to the Friesian breeders for their honesty in bringing out some of the defects of the breed into the light of day, and if the breed societies would only face the fact that it was, in the end, a much wiser policy to admit defects and have a little light thrown on them, everyone concerned would be grateful. It was known that certain of the beef breeds suffered from leg defects due to a concentration on trying to breed a straight short leg and if the tendency continued some of these breeds would be in real trouble. One could think of a particular breed of sheep which had been ridden with a particular disease for years, the breed society had been loath to admit its existence and they were now unable to export the breed to three of the principal sheep-breeding countries of the world. If they had been a little more forthright they might not be in that lamentable position to-day.

The other point which he wanted to mention was the question of the widespread use of antibiotics both as food additives and for treatment purposes. He was not one of those people who kept on bemoaning the problems which new techniques and new treatment brought with them, but he did think one must continually think about the problems which antibiotics were creating for them. They talked glibly about the risks of resistant organisms becoming predominant, they spoke very loosely, implying that they were in fact training organisms to become resistant. He did not think that was altogether true, all they were doing was to get rid of susceptible organisms and allowing a small proportion of resistant organisms which were always there to come up and dominate the picture.

Williams Smith and his colleagues in the Animal Health Trust had produced a paper which clearly showed the risk of feeding an antibiotic-fortified feeding-stuff to calves on a certain farm for a year or two, with the result that they were unable to use these antibiotics when they were needed for therapeutic purposes. These problems were right on the door-step, we could not continue to ignore them, and that brought him to his next point.

The problems of the use of antibiotics could not be intelligently approached without adequate diagnostic laboratory facilities. He was sure Mr. Hignett would agree with him, although he did not mention it in his paper, that one of the big advances in veterinary work was the wide extension of laboratory diagnostic facilities. Those who could cast their minds back to practice before the war would realise how desperately difficult it was to get laboratory help in those days, and largely the profession had the Veterinary Investigation Service of the Ministry to thank for the very much improved facilities which they had to-day, but they must not assume that they had enough. He was quite certain that one of the big needs of veterinary practice was an extension of laboratory services. He was not altogether happy that these services should be entirely part of the Veterinary Investigation Service. He was not complaining that they did not give good laboratory aid, they did, but it would help if there were alternative services, and schools and colleges should certainly try to extend their diagnostic facilities. Such a view was not always very popular in the schools, so many recent graduates wanted to do research and diagnosis was not regarded very favourably, but he was quite convinced that that should be one of the services which the schools should give. He was also certain that a laboratory service was 10 times more valuable if the people running it got out into the field so that they actually saw the problems which they had to take back to the laboratory.

This brought up the question of money. Laboratory services were expensive and he thought this was something which the profession must face that at the moment the veterinary surgeon in practice was getting his laboratory service very cheaply, it was subsidised and if veterinary surgeons had to pay the true costs of the laboratory help they were getting they might think twice about it. It was very nice that a beneficent Government should continue to subsidise laboratory services but if laboratory facilities were to be extended the profession might have to think how they were to be paid for.

He could not let Mr. Barton Mann get away with one or two of his remarks. He was a little tired of hearing about the importance of nutrition, he quite agreed it was important, but so often the exponents of this view gave no facts about the particular types of nutrition which were important. How were Mr. Barton Mann's turkeys fed so that they never got disease? One must have detail. He thought Mr. Barton Mann was not quite fair when he tended to decry modern treatments by chemotherapy and he would suggest to him that the size of his turkey enterprise would be very much smaller if his customers were not able to use modern chemotherapy when they took his birds home.

Mr. W. A. Poole (Surbiton) thought that the important point in Mr. Hignett's paper was "What is in the future?" rather than "What of the present" and there were some principles which should be borne in mind or emphasised. One of the great troubles in assessing animal health was the lack of data about the existence of disease and losses from disease. We had to put up with rough generalities. He had seen difficulty in impressing the people higher up of the existence of losses or the accuracy of statements with regard to the extent of losses. When the Agricultural Research Council set up a committee on brucellosis 25 years ago the profession knew that the losses from brucellosis were very high, but when it came to talking to the laymen concerned they continually asked for figures which the professional members were unable to give, all they had were general impressions. It was difficult to translate general impressions into convincing factual information.

The Animal Health Branch of the Ministry of Agriculture had made a good start on the collection of data on certain matters and he was sure that for the furtherance of general veterinary progress a very much wider range of data concerning animal diseases was necessary, and that type of service should be developed energetically.

What of the future? Research was the lifeblood of veterinary progress. There was no doubt about that, there was so much progress they did not know where they were, and they were all guessing. They had to be well up with the times and ahead of them if possible. Again, what about the veterinary profession in that respect? He thought they could congratulate themselves that the Association was alive. Progress in the last 20 years was tremendous compared with earlier years. The record of the Association in putting out its Handbooks was excellent; he did not know of any other profession that could show greater foresightedness. Without Government subsidies the Association had put out important information in a wide range on how things are, and how animal health required to be protected.

In the past animal welfare matters had not received enough attention at the planning stage from the veterinary profession.

Buildings had tended to be designed with all the emphasis on economy in construction and on economy in the man/hour service required to care for the animals. Insufficient attention had been paid to matters concerning hygiene and disease control. As a result disease costs far more than the economies had been allowed for.

The lesson, all round, was that the veterinarian must be an indispensable adviser at the planning stage on all matters relating to animal health. Hitherto, like the old-fashioned conception of the family doctor, he was called in to deal with illness only when it occurred. There was every indication that the profession was alive to the responsibilities, but it would have to assert its position and lead, and not wait to be invited to give an opinion.

Mr. G. F. Smith (Milk Marketing Board) said that he was pleased to see that Professor Hughes paid attention to the problems concerning genetic processes. Being connected with the dairy industry and artificial breeding he felt it important to try to forge a link with the practising members of the profession as a hopeful liaison between the field and the breeding industry. Professor Hughes had paid a compliment to the Friesian Society and he thought that that Society was indeed very forthright in what it had done so far. There was much more no doubt that could be done by every Breed Society in this country. The parent society in Holland had faced the problem and there had been a recent

useful publication by Stagenger and other workers who surveyed the recessive problems met with in the breed. Attention should be drawn to this particular reference which said that it appeared after fairly careful study of that single breed that only approximately 1 per cent. of the recessives mentioned were in the lethal category. The situation should therefore not be viewed out of its correct proportion. On the other hand, those in practice would be doing the breeding industry a great service if they brought to their attention the problems met with in the field.

It was pleasant also to see that Mr. Hignett had made reference to the improved methods of breeding which were at the present time being tried out. From his mention of the R.B.V. they probably knew that the breed societies had not been too well disposed toward R.B.V. but, on the other hand, it had shown that for internal use the relative breeding value was a big step forward in improving live-stock selection.

Regarding survey work, there were others in the audience far more competent to comment than himself but being fairly closely associated with the dairy industry he was often reminded of the lack of authentic information and detail on disease incidence. We are aware of the Weybridge survey work and perhaps we should also make reference to a more blunderbuss method of collecting material which to some extent might give us information, that was the snap method which was used by the Milk Marketing Board whereby a certain number of the lay staff were asking the milk producers in the course of their routine visits on other matters questions to which they could give a straight answer. Mastitis? How many cases in your herd? How many abortions? It was not detailed but it gave some idea of what was going on.

This brought him to his final point and that was the incidence of the various conditions of which they had heard that morning. Miss Uvarov mentioned the infectious infertility story, much more information on this was needed and perhaps a greater contribution from the profession in the field as to how present-day diagnosis methods were worked out. Mr. Hignett had endeavoured he thought to draw attention to the whole broad field of infertility and he felt they would be doing a disservice if they were to take one particular facet and give it undue publicity and overlook many of the other greater infertility problems in the field which obviously concerned them equally. He could not be in agreement with Mr. Hignett when the latter had dealt so superficially with the infectious infertility syndrome, which he (Mr. Hignett) knew as vibriosis, in fact, in his opinion, too little had so far been written on field experience about the subject.

Mr. J. B. White (Salisbury) said that he had only two items which he would like to mention, not generalisations, but two items which he saw as a practitioner, one was the influence which present-day grassland management had on metabolic diseases. He was in entire agreement with the statement made by Professor Hughes that they must regard the difficulties which they ran into as a penalty of the advances which had been made. He did not wish to detract from the advantages which had come but there had been disadvantages and the metabolic diseases deserved a great deal of attention.

Research workers seemed to him to have rather suggested that the composition of grass was relatively static. Some work was published a short time ago on the question of magnesium which showed that the top dressing of pastures with magnesium could materially alter the magnesium content of that pasture, and he would put forward a suggestion that just in the same way as a highly refined diet was not necessarily the best food for man or animal to live upon, so the present highly refined fertilisers which were being used were not necessarily the best means of fertilising grassland. That boiled down to the fact that they were still insufficiently acquainted with all the requirements of that grassland and when the time came and more was known about it, it would be possible to add to these fertilisers the necessary extra ingredients now missing and that might overcome a good many of these troubles. The problems one saw principally were either hypomagnesaemias, milk fever, and probably acetonaemia, but there was another looming up in the foreground—the question of solids not fat. He could not help feeling that the metabolic diseases which were known and that problem were closely linked, and might be shown to be in some way tied up with the fertilising problem on farms.

The second question he would like to stress as requiring considerable attention was the question of parasitism which was linked up again with high grass production and he felt they must look forward to the day when they could go on to a farm and advise the farmer how to graze his pastures to avoid clinical parasitism. It was difficult to do so now or to tell a farmer he could take his animals on to a particular pasture without running into danger. Much more was needed to be known about the life history of these parasites and about what constituted safe pasturage, how long to leave a pasture empty, how long the grass should be before the animals grazed it, and whether it was useful for young stock.

Dr. A. W. Stableforth (Weybridge) said that there were two things about Mr. Hignett's paper which struck him as absolutely typical. Mr. Hignett and he had worked together for many years. Firstly, Mr. Hignett had stated what had been done and felt no embarrassment in saying that a good job had been accomplished. He had also commented that in many of the problems there were at present no answers. Secondly, Mr. Hignett had modestly said nothing about his own work in recent years, he would like to hear a little about the classical work Mr. Hignett had done on nutrition in relation to animal health; he would be the first to say that the answer was complex and perhaps in some respects a little confused, but it would be possible by long-term experiments to understand these things.

Much was said about the effect of nutrition on disease but they must get facts about it. His own view was that quite apart from the metabolic diseases and things of that sort which were directly associated with nutrition, there was possibly, and he thought probably, quite a lot of connexion between nutrition and many of the diseases of bacterial or other infective origin, diseases due to what he would call threshold pathogens. The more acute diseases had been dealt with and now they came to the diseases in which nutritional and other factors played a part.

Mr. Hignett had also said that they did not yet understand oedema disease. They did not, but Timoney in Ireland made a most important step forward when he showed that with a centrifuged extract of bowel contents it was possible to set up bowel oedema. At Weybridge it had been found recently that there was a particular form of *B. coli* concerned and that it was possible to get an extract from these which set up bowel oedema. That was not the whole story, but it was a step forward and they hoped that soon a little more would be learned. Finally, with regard to the collection of disease data, in Harry Steele-Bodger's time there had been a scheme to try to get that data, through the co-operation of veterinary surgeons in practice but it had proved too onerous and time consuming and it fell to Weybridge to get somebody on to the job. A survey had been going on for some years under Dr. Withers to try to find out the best methods of dealing with this matter. They had now got to the stage when it might be considered on a national scale, and Mr. Ritchie had agreed that a pilot scheme should be set up in a few counties with a random sample of the herds. If that succeeded he was hopeful that enough money and staff could be found to have a national survey on a random sample which would give current records year after year of diseases in this country of the non-reportable kind for which there was at present no adequate data.

Mr. J. N. Ritchie (Chief Veterinary Officer) said that he was so accustomed to being the bull's-eye for all the arrows shot at the Animal Health Division that it was refreshing to hear someone who had something superlatively good to say about it. He felt that Mr. Downham was on the right lines in making a critical approach to what had been done but one did expect one's critics to be reasonably well informed. Mr. Downham spoke about the situation with regard to tuberculosis and the sampling of milk from herds. It was the fact nowadays that such a high percentage of the milk sent through Milk Marketing Boards came from tubercle-free herds that the necessity for the traditional samples to be obtained was much less than before.

Such samples were still taken and the same action was taken in following them up, as was done in the days before the Animal Health Division was created.

There was only one other thing of a slightly critical nature which was said that morning by Miss Uvarov, might he say that the Division was parturient of its Annual Report?

In reading Hignett's paper it was extremely difficult to take up the points which deserved discussion, it was an extremely wide paper and would give food for discussion for the whole of the morning and still longer, but one thing which did strike him was that so frequently Mr. Hignett mentioned disease which in one way or another had been concerned with the imports which had had to be made into this country. He spoke about the specific condition in Friesian cattle, foot-and-mouth disease, rhinitis, fowl pest and swine fever. All these were conditions which in one way or another had been associated with imported animals.

The title of the paper almost suggested to him that one should think about the comparison of Britain with other countries at the present moment. In his view one of the most serious difficulties, at any rate in connexion with the infectious diseases and to a great extent with other conditions, was that this country was not like so many other countries, self-supporting in so far as live-stock was concerned; we were required to import material for food and from time to time stock was imported to improve the stock in this country. He thought he might say in parenthesis that the imports which had been made in this way had never been highly successful. However, they were in the position that they had to make imports, and this country must in some ways compare unfavourably with other countries as a result because it was subject to invasion by these various diseases, notably foot-and-mouth disease. He believed if sufficient material from safe sources could be found it would go a long way towards relieving themselves of the burden of the periodic visitations of this virus disease.

He thought, again comparing themselves with other countries, they could look at it in this way, that in so far as the control of diseases was concerned there were two things absolutely essential; the first was knowledge of the disease and the second was the organisation with which one could cope with it. He thought tremendous strides had been made in adding to their knowledge and it was not only the knowledge that had already been gained which comforted him but the fact that there was such an organisation for research. So much more was being done in so many more places in this country nowadays that there was the potential for adding to their knowledge so that they might answer the problems of many other disease conditions. The staffs of the veterinary schools had been so increased in recent years and it was of tremendous value that all the schools were not only intent on teaching the young entry but were so hopefully engaged on valuable research work.

When one compared the organisation in this country with that in others he thought, again, they could feel rather comfortable. For one thing the whole of Great Britain was under the Animal Health Division of the Ministry for control of animal diseases. Further, there were very few places in which the veterinary surgeon in practice was brought in so closely with all the types of work which went on in controlling disease in the country. That was a most important and fundamental feature of the organisation here. With that and with the growing advisory service and with the Animal Health Division engaging itself in endeavouring not only to control but sometimes to eradicate disease, he felt that they were on a good wicket in this country in so far as animal diseases were concerned and while they should not be complacent he did feel confident that they were in a formidable position.

Dr. W. R. Wooldridge (Animal Health Trust) said that he had been prompted to get to his feet because he felt Mr. Barton Mann might have wished to make some reply to the suggestions concerning the value of nutrition with regard to animal health. One or two speakers had rather implied that there was not a great body of nutritional knowledge of value from the point of view of the control of health. He did not think they meant to say that for there was, of course, a mass of rich data available for more general application, if desired. That brought him to the point he wished to make, namely, that one of the most important needs of the profession was to have a number of veterinary surgeons who were experts in allied fields of knowledge. These experts must make sure that they were in close contact with the profession and with practitioners so that there was a ready flow of knowledge to those practitioners.

Of course, the nutritional field was one of the most important for veterinary application. Unfortunately in the crowded curriculum and in the busy life of the practitioner, few were able to keep in close touch with the immense amount of factual knowledge which had been obtained on the nutrition of animals. Veterinary experts were needed to fill the gap in this and other specialist fields.

Further, he wished to suggest that there might be some value in the proper organisation in this country of what is now called veterinary public health. In certain other countries a number of veterinarians, including practitioners, were participating in this field in teams of workers tackling different problems concerned with the health of animals and of men. In the United States, for instance, veterinarians were working very closely with medical officers of health, statisticians, parasitologists, and other experts in such teams and the veterinarian was very frequently leading the team. The work being done was of high quality and of great credit to the veterinary profession. These teams were working on diseases common to man and animals, such as rabies, brucellosis, and various virus diseases of unknown character which appeared to exist, or were believed to exist in animals and birds in their own countries. This was a field of veterinary work which seemed to need further development in this country.

Twenty years ago the profession's gravest defect was the predominant spirit of isolationism which more or less reserved veterinary work as the prerogative of the veterinary profession, so that little co-operation was either received from or given to workers in allied fields. This precluded the development of experts bridging these gaps. Fortunately, this situation was improving and that was one of the advances which Mr. Hignett might have mentioned. The profession should appreciate that its very existence depended on the soundness of its economic position. As its status improved and if it was to command the position which their training and experience required, they must cheapen the veterinary service to the community so that it could be much more widely spread. It seemed to him that this could only be done by admitting a variety of supernumeraries within the veterinary field to work closely under veterinary supervision.

To summarise, he believed it to be in the interests of the profession and its work to develop more veterinary experts in allied fields, and secondly, to extend their work and influence by admitting cadres of supernumeraries under close veterinary supervision.

The Reply

Mr. Hignett, in reply, thanked the speakers who had paid tribute to his paper. He said he would also like to thank Sir James Scott Watson for his most interesting opening of the discussion. He confessed that he really wondered if some of the speakers who claimed to have read his paper had actually done so, for he found it difficult to get any agreement between what they said they had read and what was actually in the paper.

Referring to Mr. Downham's comments, he thought that the proof of the pudding was in the eating. Of course, mistakes had been made, that was inevitable, but he stood by what he had mentioned earlier, that at no time had progress equalled that of the post-war era.

Mr. Rankin called for accurate data on disease incidence. This need was recognised in the paper. For years he had been a member of the Technical Development Committee which had struggled to get this information, and the members of the Committee were greatly indebted to the Animal Health Division for the efforts being made to fill this gap in their knowledge. He felt that the point raised by Mr. Rankin had been answered by Dr. Montgomerie.

Mr. Barton Mann was talking to the converted when he said more attention should be paid to grassland management. Some of them had been grappling with the problem of metabolic diseases and were well aware that one of the factors

contributing to those diseases might well be found in the whole question of grassland management.

He would like to thank his chief, Dr. Montgomerie, for supporting him.

Miss Uvarov asked a specific question about mastitis and the present picture. He did not think there was any doubt that staphylococcal mastitis was a much more serious problem now than it had been before the introduction of the antibiotics. He felt, however, that the work at Weybridge must not be ignored. This went to show that the increased incidence of staphylococcal mastitis was not directly related to the removal of *Str. agalactiae*. He thought Miss Uvarov was unjust when she spoke of his omission when referring to *Vibrio fetus* infection; he thought he paid ample tribute to the Weybridge workers, in fact he made it clear that, had it not been for these workers, control of this disease would be quite impossible. She then brought up the question of antibiotic supplements. He felt that consideration of antibiotic supplements should in the main be left to the November Conference and that he should not prejudge the issue which was to be considered at some length on that occasion. As far as his own opinion was concerned he felt that these food additives had come to stay, he felt that they certainly had a place in animal nutrition. Undoubtedly, there was still much to be done, and he would like to make the point that the voluminous literature now available dealing with this subject of antibiotic supplements was worthy of perusal, but it added confusion to confusion, since so many of the reports were conflicting.

He would like to thank Professor Hughes for his kind remarks, and he agreed whole-heartedly with what he said about diagnostic facilities although, of course, he would point out that he said just the same thing in paragraph two of his paper. With regard to the mysticism of nutrition, he knew exactly what Professor Hughes meant. He was not disinterested when it came to the question of the influence of nutrition on animal health, but he did think that a great deal of harm was done by claims which were not supported by experimental evidence. He felt that Professor Hughes was rendering a valuable service when he counselled caution in that respect. Like Professor Hughes, he was very interested in the impact of environment on animal health. There were times when it would appear that environment had a bearing on the importance of infection, but he always remembered something which was said by Dr. Stableforth at the Eastbourne Congress. For a long time they had been talking about Johne's disease, many speakers insisted on drawing attention to the importance of environmental factors so far as that problem was concerned, and then Dr. Stableforth brought them back to earth by pointing out that without the Johne's bacillus there would be no Johne's disease. He felt that they should bear that in mind more often when talking about some of these disease syndromes. Even to-day in so many cases it was much easier to go straight for the infective agent than it was to correct various environmental factors which were contributing to the problem.

Mr. Pool, of course, wanted more evidence about disease incidence, but he had already covered that point.

Mr. Geoffrey Smith seemed to think that there was something underhand about the fact that he dealt with genital vibriosis in one part of his paper and physiological infertility in another. If Mr. Smith read the introduction he would see that he had dealt with problems under various headings, two of which were infection and metabolic disorders. Consequently, genital vibriosis under infection and physiological infertility under metabolic diseases.

Mr. J. B. White, as usual, talked a lot of sound common sense, and he reminded him of an occasion when there was a big agricultural gathering in Sussex at which the chief speaker was Sir George Stapledon. They all awaited the great man's address and he started off by saying, "My Lord, ladies and gentleman, after nearly 40 years of unceasing endeavour I can now grow grass which is the perfect food for the dairy cow. There is only one difficulty as far as I am concerned, I have not yet persuaded the unmentionable cow that it is the perfect food for her"!

He would like to thank Dr. Stableforth especially for his very kind reference to their work. He did not wish to bore the meeting with details, but he could say that the position had been reached when they had satisfied those very exacting people, the statisticians, that they could influence reproductive efficiency in heifers free from genital infection by adjusting mineral intake and, furthermore, there was experimental evidence that susceptibility to genital infection in cattle could be altered by feeding. These findings were reported at the recent Third International Congress on Animal Reproduction at Cambridge.

He agreed with the Chief Veterinary Officer that his paper could have been written entirely from the basis of comparing this country's position with the position as it existed elsewhere. He confessed to having been given the title of the paper and wondering how best to write something to fit that title, and the approach mentioned by the C.V.O. did not occur to him. He wished he had met the C.V.O. at the time, when he might have written along the lines suggested.

Dr. Wooldridge referred to valuable information regarding the influence of nutrition on animal health; he acknowledged the omission in his paper, he might well have referred to it. Dr. Wooldridge had given them food for thought about these supernumeraries, but he was not prepared to go all the way with him.

After this discussion he must admit that this was the sort of paper he liked to write, because it could not possibly please everybody and was therefore guaranteed to give rise to quite a healthy discussion. One did not know whether to cover the widest possible field with the least possible detail, or a restricted field with much more detail. He tried to compromise, and, like all compromisers, he seemed to have pleased even fewer people than if he had gone to one extreme or the other.

In conclusion, he would like to say how very much he had enjoyed the session and he would like to thank those who had kept the discussion going.

Sir James Scott Watson pointed to the need for co-operation between research workers in animal health and in other fields. Plant breeders, for instance, were rather in the dark with respect to forage plants. The wheat-breeder could measure the yield of a new type, could submit the grain to milling and baking tests. The breeder of grasses or clovers was less fortunate. He instanced the case of S 100 white clover. This was a vigorous plant, competing strongly with companion grasses and much less likely to be suppressed, *e.g.*, by ryegrass. But the plant was being blamed for causing bloat and other metabolic disorders. Was this merely because of its vigour, and its consequent propensity to crowd out grasses, or was there some inherent fault from the nutritional point of view?

Collaboration between the agronomist, working for more productive pastures, and the veterinarian seeking control of pasture-borne parasites, was proving highly advantageous. There were other opportunities for co-operation.

The Chairman, Mr. E. R. Callender, expressed the thanks of the audience to Mr. Hignett for his paper and his masterly summing up, and also to Sir James Scott Watson for opening the paper, and to those who had taken part in the discussion.

Demonstrations by Close-circuit Television

On Tuesday afternoon demonstrations of various techniques were given at the Moreton Morrell Institute, near Leamington (by kind permission of the Principal), by means of close-circuit television. The rooms of the Institute were packed with members watching the demonstrations and by means of the many television screens they were able to do so in a way which would not have been possible under ordinary conditions. The television pictures were very clear and very well presented.

Mr. S. Jennings, opening the proceedings, said that those who had attended Congresses in the past would remember many a field test of demonstrations and operations (always a popular feature of Congress) which had been difficult to watch because of the enthusiastic crowds milling round the demonstrators. This year Congress was indebted to the Provisional Committee and the Local Committee, and particularly to Mr. McGhee and Miss Rogers for arranging for the close-circuit television as a result of which everyone would be able to see and hear all that was going on and have, as it were, a front seat.

A number of eminent members of the profession, experts in their own particular line, were to give the demonstrations.

The programme was as follows :—

Demonstrations	Demonstrators
Laparotomy of the dog by paramedian approach and reflexion of the rectus muscle. Bowel resection and end to end anastomosis.	Mr. G. C. Knight, F.R.C.V.S., assisted by Mr. R. C. Frost, M.R.C.V.S.
Acid firing for sprain of the flexor tendon in the fore-limb of the horse.	Brigadier E. S. W. Peatt, O.B.E., F.R.C.V.S.
Caslick's operation for perineal repair of the mare.	Mr. R. C. Crowhurst, O.B.E., M.R.C.V.S.
A case of scrapie.	Dr. W. S. Gordon, C.B.E., M.R.C.V.S., F.R.S.E. (Mr. J. Deans Rankin deputised in Dr. Gordon's unavoidable absence.)
Clinical examination of the hen.	Mr. E. G. Morris, M.R.C.V.S.
Post-mortem examination of the hen.	Dr. J. C. Buxton, B.SC., M.R.C.V.S.
Post-mortem examination of the pig.	Mr. E. G. Morris, M.R.C.V.S.
Atrophic rhinitis: demonstrations of macroscopic lesions.	Mr. J. T. Done, B.V.SC., M.R.C.V.S.

Present Day Toxicity Problems—A Review

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THE enormous increase in the range of substances to which stock on the farm and animals reared as pets are, to-day, actually or potentially exposed either by design or accident, has led to an increasing number of problems for those concerned with veterinary toxicology. Nevertheless, the fundamental essentials of these problems do not seem to me to differ in anything other than degree or extent from those with which veterinarians have always had to deal. Domestic animals have always been subjected to hazards arising from negligence and ignorance in the proper storage, application and methods of disposal of toxic substances, and those concerned with the care and health of live-stock have always had to take cognisance of the possibility of toxicological accidents.

To-day's problems arise largely from the lack of adequate facilities for the dissemination of useful and reliable information about the benefits, and methods of application and hazards attendant on the use of the ever-increasing flood of chemicals which is finding its way into the food and environment of animals, and into procedures and treatments designed to safeguard public health, and to ensure and enhance food production. They are also due, to a certain extent, to the precipitate introduction for general use of substances or procedures which have not received adequate experimental investigation and, from the viewpoint of the clinician and toxicologist, to the fact that reliable methods for the diagnosis of poisoning are not always available. Nevertheless, it should be noted that in Britain, even to-day, and despite the vastly increased use of toxic chemicals like the newer pesticides, the vast majority of cases of poisoning on the farm are still due to the ingestion of lead and arsenic-contaminated materials and foodstuffs.

It will be appreciated that this communication must be limited in its coverage, and that many substances which produce poisoning on the farm cannot be included. A considerable selection of the topics for discussion has been made, with no intention of implying that those not discussed are unimportant, and comments are restricted to lead, arsenic, copper, fluorosis, bovine hyperkeratosis, sulphonamide toxicity in poultry, certain rodenticides, organomercurial fungicides, the chlorinated hydrocarbon and organophosphorus insecticides, and the hormone and dinitro weed-killers. The references quoted are by no means exhaustive and are merely indicative of the major sources from which the information given is derived.

I. Lead

Fatalities resulting from the consumption of lead-contaminated materials are among the commonest causes of death from poisoning on the farm (Allcroft, 1951; Orr, 1952; Rept. on Anim. Hlth. Services, Gt. Britain, 1953 and 1954; Udall, 1954; McIntosh, 1956; Beijers, 1956). Calves, probably because of their licking propensities, are the animals most commonly affected, but cases in other animals, particularly poultry and other birds, are not infrequent. Recent publications (Staples, 1955; McIntosh, 1956; Dodd & Staples, 1956) suggest that, in New Zealand at any rate, lead poisoning in dogs may be more frequent than is generally recognised and that the symptoms exhibited may simulate those of distemper, Rubarth's disease or canine hysteria.

Lead-containing paint or painters' materials are the commonest causes of poisoning, *e.g.* painted wood or metal, discarded paint tins, paint scrapings, putty (red or white lead), old painted tarpaulins or roofing felt, old lead plates of batteries. An intensive search is often required before the source of the lead is discovered. It may be covered by whitewash, or by bituminous paint.

Acute poisoning is the usual form in farm animals. With large doses death may occur without symptoms, or follow a short period of nervous excitability and convulsions. In such cases symptoms and death usually occur within 24 hours. With smaller doses symptoms may not occur for several days and include dullness, inappetence, abdominal pain, grinding teeth, salivation, constipation, excitement, apparent blindness, muscular spasms, tetany and death. The lethal dose appears to be in the region of 0.15 to 0.25 mg. Pb per kg. bodyweight, but individual susceptibility varies considerably, and older animals are less susceptible than young.

Post-mortem examination reveals little of diagnostic significance though there may be some evidence of gastritis and enteritis and petechial haemorrhages on the kidneys and epicardium.

Diagnosis depends on circumstantial evidence, history and symptoms, if any, the elimination of other causes of death, and on chemical analysis. In our experience at Weybridge calf kidney cortex values of 25 p.p.m. (parts per million) or above provide good presumptive evidence of lead poisoning, while levels of 10 to 25 p.p.m. should be regarded as suspicious and carefully assessed in conjunction with other collateral evidence. In calves, kidney cortex values are more reliable guides to lead toxicity than are liver values. In poultry, liver values above 10 p.p.m. are regarded as affording supporting evidence for a diagnosis. In bovines, normal liver and kidney values, blood levels, and faeces values are taken to be up to 3 p.p.m. wet weight, 0.05 to 0.3 p.p.m. and 1 to 40 p.p.m. dry matter respectively. In surviving animals, blood and faeces analyses may have some prognostic as well as diagnostic value. High

values for blood and faeces suggest recent ingestion and a poorer prognosis than high blood and low faeces levels suggesting a less recent ingestion.

Within recent years calcium disodium ethylene diamine tetra-acetate (EDTA) has been used for treatment (Holm *et. al.*, 1953; Lewis & Meikle, 1956; Dodd & Staples, 1956), but it is difficult to assess the efficiency of this form of therapy.

II. Arsenic

Because of its widespread use in preparations designed for insecticidal, parasiticidal and herbicidal purposes, arsenic is one of the commonest toxic substances used in agricultural practice. Cases of poisoning in stock are of comparatively frequent occurrence (Boddie, 1947; Orr, 1952; Udall, 1954; Beijers, 1956). During the last few years sprays containing considerable quantities of sodium arsenite have been used on an increasing scale (in place of sulphuric acid or other chemicals) for the destruction of potato haulms, and to facilitate mechanical harvesting (Rept. Anim. Hlth. Services, Gt. Britain, 1953; *Toxic Chemicals in Agriculture*, 1955). Fatalities to stock which have gained access to sprayed crops through open gates or broken fences have been reported and cases have occurred as a result of spray-drift contamination of grazing land. Carelessness in using and disposing of arsenical sheep and cattle dips, and the contents of foot-bath tanks, is another common cause of stock poisoning.

The fatal dose of arsenic varies widely according to its purity, the degree of fullness of the stomach, and whether it is in solution or in the form of a fine powder. The acute $L.D._{50}$ for animals is in the region of 10 mg. per kg. bodyweight; symptoms vary. Animals may be found dead, or be struck by a sudden acute illness with marked prostration, colic, vomiting in those species capable of so doing, and painful gastro-enteritis. Death may occur within three to four hours, or not for several days.

Diagnosis depends on circumstantial evidence, history and symptoms, *post-mortem* findings, and chemical analysis of stomach and intestinal contents and liver. It should be remembered that detectable quantities of arsenic can be found in the tissues of many normal animals. It is usual to find liver values of more than 10 to 15 p.p.m. As_2O_3 on a fresh weight basis in animals which have had a lethal dose of an arsenical compound, but in a few cases in older bovines where the history afforded strong presumptive evidence of arsenical poisoning, values as low as 7 to 10 p.p.m. have been found. Nevertheless, it must be remembered that in countries where arsenical dips are used regularly liver values of up to 8 p.p.m. have been found frequently in healthy animals at slaughter. So, too, abnormal amounts of arsenic in stomach and intestinal contents can be regarded as suspicious of poisoning but should not be taken as definitely confirming poisoning in the absence of liver values indicative of absorption. Levels of several hundred p.p.m. have been found in the alimentary tract contents of sheep which have ingested sub-lethal amounts of dips, or have been given harmless doses of arsenical wire-worm drenches.

III. Copper

Copper compounds are widely used on the farm as fungicides in orchards, as drenches for the treatment of stomach worms in sheep, as molluscicides against snail vectors of disease, as mineral supplements and, recently, as additives to calf and pig meals. Their toxicity varies greatly for different animal species and some farm animals, *e.g.* sheep, can be poisoned by relatively small quantities.

Cases of poisoning in sheep which gain access to orchards which have been sprayed with copper-containing fungicides are not uncommon. The animals appear to accumulate copper in their livers and stress conditions of any sort may then initiate a so-called "haemoclastic crisis." The onset of symptoms (which may not occur for days or weeks after the liver accumulation of copper) is rapid, and the condition is characterised by haematuria, inappetence, icterus, and extreme weakness. *Post-mortem* findings include a yellow-orange liver, dark brown kidneys and generalised icterus. Liver copper values are high—commonly in excess of 1,000 p.p.m. (Broughton & Hardy, 1934; Fincham, 1945; Ogilvie, 1954).

Copper poisoning may also occur in sheep which are fed copper-containing mineral supplements; care must be exercised in the use of such materials, particularly in pedigree animals which are well-fed and housed for part of their lives. With cattle, too, care is necessary, particularly so in young animals of good copper status. A comparatively recent innovation is the use of calf and pig meals containing copper additives; whether or not such additives lead to appreciable toxicity hazards remains an open question but the possibility that such feeding may lead to toxicity incidents cannot be entirely excluded (Allcroft, 1956). A factor which may be important here is the difficulty of ensuring that copper added to meals is adequately and evenly dispersed throughout the entire meal batch.

IV. Fluorosis

This problem has been well reviewed (Blakemore, Bosworth & Green, 1948; Boddie, 1949; Towers, 1954; Allcroft, 1956). As is well known, it arises in this country from atmospheric contamination of herbage from emissions of fluorine-containing gases and particulate matter from industrial works, and is not related to high fluorine content of water supplies or phosphatic rocks, as it is in many parts of the world. It is of interest to note that while fluorine contents of drinking water in the region of 2 p.p.m. may produce mild mottling (white flecks) of the teeth of children, no effects are produced in cattle and sheep unless their drinking water contains at least 4 to 6 p.p.m. (Steyn, 1938).

Acute fluorine poisoning followed by death in a few days as a result of accidental ingestion of large doses of soluble fluorine compounds such as sodium fluoride is not of frequent occurrence. It is the effect of long-continued ingestion of small amounts either in foodstuffs or drinking water which presents the problems of economic importance. The term "fluorosis" is used to indicate this chronic disease,

rather than the term "fluorine poisoning" which implies the acute condition.

The animals chiefly affected by fluorosis are cattle. Present evidence suggests that the order of susceptibility of farm animals is calves, dairy cows, other bovines, sheep, pigs, horses and poultry, but this order may be revised when it has been possible to carry out comparative tests on a known and comparable bodyweight intake. Factors such as methods of management may affect this order materially.

It is perhaps because of the increased use of home-grown feeding-stuffs over the last 15 years that the problem of fluorosis has become more evident, but the expansion of industry over the same period must also be taken into account. Of the industries affecting local agriculture those which have been investigated include (1) production of aluminium by the electrolytic reduction of alumina, where the source of fluorine is the cryolite used as a flux; (2) brickworks, where the source is usually the local clay although coal is sometimes a contributory factor; (3) glass, enamel, and certain colour works where fluorine compounds are often added to the raw materials; (4) the calcining of ironstone where the source is mainly the ore itself with a certain contribution supplied by the coal with which it is mixed for burning; (5) steel and metal works where fluorspar is used as flux; (6) collieries using low-grade fluorine-rich coal for power supplies; (7) power stations using pulverised low-grade coal; and (8) potteries where the sources are the clay and other materials used in manufacture.

While clinical symptoms and circumstantial evidence may suggest fluorosis, it is essential to confirm diagnosis by the estimation of the fluorine content of specific tissues. For farm stock, bones are most suitable in the case of *post-mortem* material and urine samples in live animals. Herbage and soil samples provide useful corroboration but are not suitable alone for assessing degree and extent of contamination, since results will depend on climatic conditions at the time the samples are taken, on the direction of the prevailing wind, and on the topography of the surrounding terrain.

It should be noted that, while the total economic loss due to fluorosis in live-stock is not great when considered in relation to that caused by the major diseases, the problem is a matter of serious concern to farmers in certain areas and is sufficiently widespread to merit attention. To explore the possibility of mitigating the effects of fluorosis, an experimental farm at Stoke-on-Trent on which fluorosis is known to occur has been stocked with a herd of Ayrshire cows and their followers and with pigs and poultry. The objects of the investigation are to see if feeding certain mineral supplements will alleviate to some extent the effects of fluorosis in cattle—the subject of "fluorine alleviators" has recently been reviewed in THE VETERINARY RECORD (Boddie, 1955)—and to demonstrate that pigs and poultry can be reared profitably on a contaminated farm under normal management. It is felt that if the effects of fluorosis can be mitigated to some extent by feeding certain supplements and that, if, as a result of a survey of fluorosis in industrial areas which is now in progress, industries could be urged to install more efficient trapping devices, then in many areas cattle could tolerate the remaining degree of fluorosis without economic loss.

V. Bovine Hyperkeratosis ("X Disease")

This condition was first described in detail in 1947 (Olafson) and has since been reported in many parts of the world (Wagener, 1953). Hansel & McEntee (1955) present a review of the literature and discuss the position from the American viewpoint. The first outbreak in this country was described by Loosmore (1953).

The symptoms and lesions of "X disease" are numerous, the skin effects being characterised by the development of hairless, dry, greyish, thickened and wrinkled areas which may cover a large part of the upper part of the body or be confined to local areas, *e.g.* the neck. There may be profuse lacrimation and salivation, depression, anorexia and loss of condition, diarrhoea, mastitis and dystocia. Papillary proliferations on the tongue, oral mucosa, oesophageal mucosa, and in the gall bladder and large bile ducts are common, and cystic dilatation of the renal tubules, and gastric and intestinal glands have been described. Marked pathological changes occur in the reproductive tracts of both males and females.

The isolation and identification of the causative agent was troublesome, but in 1952 evidence from three sources showed that highly chlorinated naphthalenes were the cause of the disease (see review by Hansel & McEntee, 1955). It appears that the higher the degree of chlorination, the greater is the hyperkeratosis-producing property of the compound. These substances have been used in lubricants, and cases have occurred as a result of animals consuming food contaminated by lubricant in feed-pelleting machines (Copenhaver & Bell, 1954) and in animals which have licked grease on farm machinery. Potentially dangerous compounds of this type to which stock might have access occur in lubricants and motor "tune-up" oils, electrical insulating compounds, paints and preservatives, floor finishes and varnishes, and binders for ceramics. In contrast to cattle, goats, sheep, pigs, mice, chickens and rats all appear to be relatively resistant to chlorinated naphthalene poisoning (Hoekstra, *et al.*, 1954; Olafson, *et al.*, 1955).

It was soon noted that the condition produced by chlorinated naphthalenes simulated many of the features of vitamin A deficiency and analysis revealed that a rapid decline in blood vitamin A levels occurred in affected animals (Engel & Bell, 1953). Indeed, vitamin A therapy has been suggested as a useful form of treatment. There is, however, some doubt about an early suggestion that the effect is due to an interference with the conversion of carotene to vitamin A. It has also been suggested that these substances possess anti-vitamin E activity (Hove, 1953).

Although many outbreaks of "X disease"—particularly in America—have now been traced to highly chlorinated naphthalenes, some cases are still unexplained. It is of interest to note that there is

considerable evidence to show that certain topically applied oils are capable of producing hyperkeratosis (Hoekstra, *et al.*, 1955). Apart from the skin condition and an apparently non-critical, transient blood plasma vitamin A depression, these petroleum oils do not seem to produce any other effects of "classical" X-disease. The evidence available suggests that the condition produced by the oils (which contain no organic chlorinated compounds) is of entirely different origin from that of chlorinated naphthalene poisoning, but the situation remains somewhat obscure and further information is required before it can be clarified.

VI. Sulphonamide Toxicity in Poultry

Adverse side effects from the use of coccidiostatic drugs have not been reported very commonly but Davies & Kendall (1953) described toxicity following the use of sulphaquinoxaline for the control of *E. tenella* in chickens. Further aspects of the problem were reported by Joyner & Davies (1956).

From the U.S.A. there have been numerous reports of a "haemorrhagic syndrome" occurring usually in the broiler-houses where table poultry are produced under intensive conditions. In some, but not all instances, this condition appears similar to the sulphonamide poisoning described by Davies & Kendall (*loc. cit.*). Haemorrhagic disease seems to occur much more commonly in the United States than in Britain and it may be significant that the practice of using medicated foodstuffs is much more common there than here.

There is a possibilty that the toxicity specifically attributed to the sulphonamides may be avoided in the future by the use of the synergic combinations of sulphonamides and folic acid inhibitors described by Joyner & Kendall (1956). The use of these new and powerful coccidiostats may, however, produce new hazards and extensive investigation will be required before the products find general application in the field.

VII. Rodenticides

Many of the newer rodenticides are much more effective for rat destruction than are the older poisons but all are still toxic to a greater or lesser degree for all animals and care must be exercised in locating baits in positions which are not accessible to livestock (McGirr & Papworth, 1955).

Sodium fluoroacetate was identified as an effective rodenticide in the U.S.A. about 10 years ago. It has been used on a considerable scale in many parts of the world but, unfortunately, it is dangerous for other animals and particularly so for the cat, dog, pig and goat. The $L.D._{50}$ for rats is reported as between 1.5 and 7.0 mg. per kg. bodyweight, while that for the species mentioned above is about 0.3 mg. per kg. It produces cardiac and central nervous effects; in goats, horses, and rabbits the former effects predominate, in dogs and guinea-pigs the latter, while in cats, pigs, rats, hamsters and monkeys both responses are seen.

Fluoroacetate has the disadvantage common to many rat poisons of producing poison shyness and this, allied to its high toxicity for other species, has resulted in its not finding favour for general use.

ANTU—alphanaphthylthiourea was also suggested as a rodenticide about 10 years ago. It is readily acceptable by rodents in the form of bait but there is a tendency to develop a tolerance to many times the lethal dose after consumption of a single sub-lethal dose. A point worthy of note is that the Norway rat is much more susceptible to this poison than are the other rat species.

ANTU kills by producing marked hydrothorax and pulmonary oedema with profuse pleural and, to a lesser extent, pericardial effusion. Death usually occurs within 24 to 48 hours after ingestion of the poison. Chemical methods for its detection in *post-mortem* material are not reliable. The lethal dose for pigs is in the region of 40 mg. per kg. bodyweight, and for dogs about 20 mg. per kg. bodyweight. Cattle and poultry appear to be relatively resistant. It should be noted that this poison is usually used at a concentration of 2 per cent. in suitable bait and that, therefore, pigs and dogs can be poisoned by picking up small amounts of rat bait.

Warfarin — 3(*acetonylbenzyl*)-4-*hydroxycoumarin* —is a representative of the anticoagulant type of rodenticide. Substances of this type appear to be the most efficient of the available rat poisons and are used on a very considerable scale throughout the world (Clinical Memoranda on Economic Poisons, 1956). They possess the great advantage of not inducing poison shyness. The physiological actions are two-fold—inhibition of prothrombin formation and production of capillary damage. There is unconfirmed evidence that these two actions are produced by the two moieties of the molecule—thus, 4-hydroxycoumarin inhibits the formation of prothrombin and reduces blood clotting, while there is evidence that at sufficient dosage benzalacetone produces capillary damage and leads to bleeding upon the slightest trauma.

Single doses, unless very large, do not exert a lethal action but repeated small doses prove fatal as the result of haemorrhage. Rat baits are usually made up by mixing one part of commercial preparations containing 0.5 per cent. or 0.1 per cent. warfarin with 19 parts of oatmeal or other suitable diluent. The latter type of bait kills the common rat in five to eight days with a daily consumption of poison in the region of 1 mg. per kg. bodyweight. Poultry and calves are resistant, and, while certain other birds may be slightly more susceptible, it seems unlikely that poisoning can occur in these species under normal baiting conditions. Pigs, cats and dogs, on the other hand, are comparatively susceptible and cases are not infrequent (*e.g.* Clark, 1954; Cotchin, 1955; McCarroll, 1955). In pigs, repeated doses of 0.3 mg. per kg. bodyweight can produce symptoms and death, while in dogs and cats susceptibility is variable.

Symptoms of poisoning are not constant. Animals may be found dead because of massive haemorrhage into the body cavities or brain, or may show evidence of bleeding into the subcutaneous tissues and musculature with lameness for a day or two before

death. *Post-mortem* findings depend on the area in which haemorrhage occurs. Unfortunately, satisfactory and reliable chemical methods for the detection of warfarin in relicta are not available. Diagnosis must depend on circumstantial evidence, history and symptoms, and *post-mortem* findings.

Vitamin K is said to have an antidotal action against both the antiprothrombin and capillary damage effects of warfarin and therapy with suitable preparations may be useful in suitable cases (Boddie & Burgess, 1953; Creyke, 1956).

Zinc phosphide is an efficient rat poison but is dangerous for all other farm animals as well. It is now largely superseded by warfarin for general use. A dose of 40 mg. per kg. bodyweight is lethal for the majority of farm animals, including poultry. Symptoms of poisoning and *post-mortem* findings are not specific, a firm diagnosis being dependent on chemical analysis. The method used should detect phosphine; analytical values for zinc cannot be taken as reliable evidence of the presence of zinc phosphide in tissues (Fitzpatrick, McGirr & Papworth, 1955).

VIII. Organo-Mercurial Fungicides

Methyl, ethyl and phenyl mercurial compounds have been used for many years in certain agricultural practices—notably as fungicides in horticulture and in the dressing of seeds. It is known that these substances can be dangerous when used carelessly, but the special chronic risks attendant on their preparation and use was brought sharply forward recently by the death of a man who had been engaged in their manufacture (Hunter & Russell, 1954). The 1956 regulations under the Agriculture (Poisonous Substances) Act of 1952 include for the first time conditions under which organo-mercurial compounds can be used in certain horticultural practices.

Possibly the main interest from a veterinary viewpoint in organo-mercurial toxicity is the fact that occasional questions are raised regarding the incorporation of dressed seed (surplus to sowing requirements) in animal feeding-stuffs. Such seed has been used in the past in compounded poultry foods at a level of 10 per cent. without untoward effects, but the toxicity of different organo-mercurials may vary and competent advice should be sought before any such feeding is undertaken.

IX. The Chlorinated-hydrocarbon Group of Insecticides

This section deals with the general toxic properties of DDT, aldrin, dieldrin, chlordane, BHC, toxaphene, methoxychlor, DDD, isodrin, endrin and heptachlor. Though from a strict chemical point of view some of these compounds should not be classified as hydrocarbons, it is convenient to do so from a toxicological angle because, though possessing diverse chemical structures, all have many toxic properties in common. Very useful general reviews on the toxicity of this group of compounds are published in the Bulletin of the World Health Organisation (Barnes, 1953) and in a publication of the U.S. Department of Health, Education and Welfare (Clinical Memoranda on Economical Poisons, 1956), while specific information on acute toxicity to livestock is given in Technical Bulletin No. 1122 of the U.S. Department of Agriculture (Radeleff *et. al.*, 1955).

In acute poisoning by any of these substances, the first sign is increased irritability and excitability followed by fine and coarse muscular tremors, weakness and paralysis; convulsions occur in cases of severe poisoning. Salivation and grinding of the teeth are common in the larger animals, and species capable of doing so habitually vomit. Anorexia is a striking feature in all cases of severe poisoning and may lead to considerable loss of weight. All of the compounds are stored in the body fat but the concentration in which they are stored in relation to the quantity ingested varies considerably from compound to compound; so, too, does the time for which they remain in the fat after ingestion ceases. The question of excretion in milk is of considerable importance since, after absorption, quite considerable quantities may be excreted by this route and indeed, toxic symptoms may be produced in suckling animals while their dams are apparently perfectly normal (Kästli, 1955).

DDT. The single lethal dose when given orally in vegetable oil is about 200 mg. per kg. bodyweight for most mammals. Cats and mice are slightly more susceptible, and dogs and rabbits less susceptible. Apart from the very young, the larger animals and birds are appreciably less sensitive. Repeated daily doses of 20 to 25 mg. per kg. bodyweight produce serious poisoning in rats and dogs in several weeks.

DDD and *Methoxychlor* are less toxic than DDT.

Aldrin. When given by mouth as a single dose the toxic dose for calves one to two weeks old appears to be 2.5 to 5.0 mg. per kg. bodyweight, for cattle 10 to 25 mg. per kg., and for sheep in excess of 10 mg. per kg. Repeated daily doses of 2 to 5 mg. per kg. bodyweight will kill dogs, sheep and cattle within from a few days to a few weeks. There is some evidence that batches of aldrin prepared by different processes may differ in their toxicity.

Dieldrin. For calves one to two weeks old the acute oral toxicity of a single dose appears to be 5 to 10 mg. per kg., for cattle 10 to 25 mg. per kg., and for young pigs 25 to 50 mg. per kg. The maximum tolerated concentrations when applied in the form of a spray appear to be 0.1 to 0.25 per cent. for one- to two-week-old calves, 1 to 2 per cent. for cattle, 0.2 to 0.3 per cent. for young lambs and about 4.0 per cent. for pigs and goats (Radeleff *et al.*, 1955). It should be noted that dieldrin (and presumably also aldrin) is readily absorbed through the skin as well as through other portals, and that toxicity and contamination problems resulting from milk excretion levels must be avoided. Jolly (1954) suggested that chickens may be quite susceptible to dieldrin toxicity and recent preliminary investigations at Weybridge indicate that pigeons succumb to comparatively small doses sometimes with a delay of several days between ingestion and onset of symptoms. Dieldrin is now used as a seed dressing and may be responsible for death in wild birds eating such seed.

Isodrin and *Endrin.* Little information is available on the toxicity of these substances but they

appear to be more poisonous than their better-known isomers, aldrin and dieldrin.

BHC. The ordinary commercial preparations of this substance consist of a mixture of isomers; the insecticidally active isomer, the gamma (known in pure, or 99 per cent. pure, form as lindane) is present to the extent of about 12 per cent. in this mixture. The average single lethal dose of commercial BHC is about 1,000 mg. per kg. bodyweight, though symptoms of poisoning have been observed in dogs receiving only 350 mg. per kg. bodyweight. For lindane the lethal dose for most animals is 100 to 200 mg. per kg. bodyweight, but Radeleff *et al.* (1955) give the minimum oral toxic dose as 5 mg. per kg. for one- to two-week-old calves, and 25 mg. per kg. for sheep and cattle, and the maximum non-toxic spray concentration as 0.025 per cent. for one- to two-week-old calves, 0.1 per cent. for cattle, 1 per cent. for sheep and pigs and 0.15 per cent. for horses. It should be noted that there is some evidence that the toxicity of the gamma isomer is altered according to the quantity of other isomers present. Continued feeding experiments with commercial BHC at doses of 50 mg. per kg. bodyweight did not affect dogs, but on the other hand, tainting of flesh and animal products, *e.g.* milk and eggs, can be produced by the consumption of very small amounts.

Toxaphene. The lethal dose for laboratory animals is about 100 mg. per kg. bodyweight but as little as 20 to 40 mg. per kg. may be fatal in dogs. The minimum oral dose to produce symptoms in young calves is about 5.0 mg. per kg., in sheep 25 mg. per kg., and in goats 50 mg. per kg. while the maximum non-toxic spray concentration for one- to two-week-old calves is 0.5 per cent., for cattle 2.0 per cent., for sheep 1.5 per cent. and for pigs 4.0 per cent. (Radeleff *et al.*, 1955). Chickens appear to be relatively resistant.

ACUTE ORAL AND DERMAL $L.D._{50}$ VALUES OF CHLORINATED HYDROCARBON INSECTICIDES FOR MALE AND FEMALE WHITE RATS

Compound	Oral $L.D._{50}$ (mg. per kg.)		Dermal $L.D._{50}$ (mg. per kg.)	
	Males	Females	Males	Females
Chlordane ...	335·0*	430·0*	840·0*	690·0*
Chlorobenzilate	1,040·0*	—	—	—
DDA ...	740·0*	—	—	—
DDE ...	880·0*	1,240·0*	—	—
DDT ...	113·0*	118·0*	—	2,510·0*
Dieldrin ...	46·0*	46·0*	90·0*	60·0*
Dilan ...	—	—	6,900·0*	5,900·0*
Endrin ...	17·8*	7·5*	—	15·0*
Lindane ...	(200·0)†	—	500·0*	—
Methoxychlor	(6,000·0)†	—	—	>6,000·0*
Toxaphene ...	90·0*	—	2,300·0*	80·0*

* These values were determined at Technical Development Laboratories under standardised conditions.

† Sex not specified.

Chlordane. The minimum oral toxic dose is about 25 mg. per kg. for youg calves and 100 mg. per kg. for sheep, while the maximum non-toxic spray concentration is 0.5 per cent. for young calves, 1 per cent. for lambs, and 2 to 3 per cent. for cattle and sheep. It should be noted that this compound is very readily absorbed through the skin.

Heptachlor exhibits toxicity values similar to those for chlordane.

The table below, taken from Clinical Memoranda on Economic Poisons (1956), gives a useful indication of the relative toxicity of a number of the chlorinated insecticides and their metabolites.

X. The Organo-phosphorus Insecticides

The organo-phosphorus insecticides are esters and amides of phosphoric and pyrophosphoric acid which, when introduced into the animal body, inhibit the enzymes that hydrolyse acetylcholine. They differ widely in their inherent toxicity and differ at least to some extent in their rate of absorption, point of maximal action following absorption, and rate of destruction on excretion. General information on the toxicity of these substances is given by Barnes (1953) and in Clinical Memoranda on Economic Poisons (1956) while specific information on acute toxicity to live-stock is published by Radeleff *et al.* (1955).

The signs and symptoms of acute poisoning by all members of the group are the same. They are those which would be expected from an excess of acetylcholine persisting at those nerve endings where it normally functions evanescently as a transmitter. Salivation, abdominal pain, vomiting and diarrhoea result from over-activity of the parasympathetic nerve supply to the alimentary tract; bronchial secretion and spasm reflect parasympathetic effects upon the bronchial tree; fasciculations, irregular contractions and weakness of voluntary muscles indicate excess of acetylcholine at the myoneural junctions. Death occurs from failure of respiration.

Chronic poisoning can be produced experimentally and some members of the group can produce, in susceptible species, serious structural changes in the peripheral nerves and tracts of the spinal cord. The chemical or physical characteristics which produce these long-term and irreversible effects on nervous tissue are not clearly established.

It should be noted that these poisons all have cumulative effects due to increasing inactivation of the enzyme cholinesterase and that even with the less toxic members of the group precautions must be taken when handling and spraying the materials. With the more toxic members intensive worker precautions are necessary. The 1956 Regulations under the Agriculture (Poisonous Substances) Act of 1952 prohibit the use of certain organo-phosphorus compounds in agriculture and horticulture unless the employees working with them are wearing protective clothing. The protective clothing to be worn varies according to the chemical and the particular operation being carried out.

Blood cholinesterase determinations afford a useful guide to degree of exposure, and can be used for diagnostic purposes. In *post-mortem* material reduction in cholinesterase levels can also be demonstrated provided fresh, unfixed tissue is employed. Such samples must be kept refrigerated, but *not frozen*, during shipment.

The following data indicate the relative toxicity of a number of organo-phosphorus compounds; the figures give the approximate average single lethal dose, when the substances are administered orally to male rats. TEPP—2 mg. per kg.; paroxon—2 mg. per kg.; dimefox—5 mg. per kg.; schradan—10 mg. per kg.; parathion—15 mg. per kg.; demeton (systox) —15 mg. per kg.; potosan—25 mg. per kg.; EPN—40 mg. per kg.; malathion— < 1,000 mg. per kg. (Barnes, 1953). The comparable figure for dipterex (compound L13/59) is in the region of 500 mg. per kg.; for diazinon about 200 mg. per kg.; and for chlorthion about 1,500 mg. per kg. (Dubois *et al.*, 1953). Published information on farm live-stock is not extensive but the following figures indicate the order of the maximum single oral dose tolerance levels for cattle and sheep (Radeleff *et al.*, 1955). Parathion —one- to two-week-old calves 0.25 mg. per kg.; cattle 4.0 mg. per kg.; sheep 10 mg. per kg.; malathion—one- to two-week-old calves 10 mg. per kg.; sheep 50 mg. per kg.; diazinon—one- to two-week-old calves 0.5 mg. per kg.; cattle 10 mg. per kg.; sheep 20 mg. per kg.; chlorthion—one- to two-week-old calves 50 mg. per kg.; cattle 50 mg. per kg.; dipterex (L13/59—one- to two-week-old calves 5 mg. per kg.; cattle 50 mg. per kg.

So far as treatment is concerned atropine in large doses may be useful; it relieves many of the distressing symptoms, reduces heart block and dries secretions of the respiratory tract. The skin should be decontaminated using mild alkali solutions and, if possible, the stomach emptied. New possibilities for the treatment of poisoning by anticholinesterases are under investigation in many parts of the world and many substances, *e.g.* hydroxamic acids and oximes, are being studied in the hope of discovering a non-toxic chemical which can reverse the inactivating phosphorylation of these enzymes.

XI. The Dinitrophenol Group of Insecticides and Herbicides

Compounds of this group are widely used as insecticides, fungicides and weed-killers. They are usually substituted dinitrophenols, alone or as salts of aliphatic amines (trimethanolamine or isopropanolamine) or alkalis (sodium or ammonium hydroxide) *e.g.* DNC (DNOC), dinoseb (DNBP). These substances are toxic to all animals, and must be handled with care. They can be absorbed in toxic amounts by inhalation or ingestion, and many of them can be absorbed through the skin to a dangerous degree (Bidstrup, 1952; Galley, 1952; Judah, 1952).

All of these compounds increase oxidative metabolism and therefore the heat production of the body, chiefly by direct peripheral action. The signs and symptoms of poisoning include nausea, gastric distress, restlessness, sweating, deep and rapid respiration, fever, cyanosis and collapse. Acute poisoning usually runs a rapid course, death or almost complete recovery within 24 to 48 hours being the general rule. Toxic doses for all animals are in the region of 25 to 50 mg. per kg. bodyweight, but toxicity may be significantly increased if the environmental temperature is high (McGirr & Papworth, 1953). Treatment is symptomatic; it has been claimed that the intravenous injection of 10 ml. of a 2.5 per cent. solution of sodium methyl thiouracil rapidly reduces the basal metabolic rate of human beings in whom the rate of metabolism has been increased by these substances (Clinical Memoranda on Economic Poisons, 1956).

XII. The Hormone Weed-killers

The so-called hormone weed-killers, *e.g.* 2,4-D, MCPA, and 2,4,5,-T, are usually regarded as non-toxic to animals at the concentrations at which they are normally applied. Nevertheless, care must be exercised in exposing stock on sprayed land, or crops. There are indications that, in poultry, continued exposure to sprayed areas may result in loss of weight and reduced egg production (Dobson, 1954) and that cattle, sheep and pigs on sprayed land may suffer. In the latter species, it seems that certain toxic weeds, *e.g.* ragwort, may become peculiarly attractive after hormone weed-killer applications.

General Comments

While it remains true that, in this country, the older poisons like lead and arsenic are still the greatest hazards to farm live-stock, the advent of many of the new pesticides has raised important problems. Health hazards to workers concerned with manufacture, distribution, application and use have to be considered, and questions arise concerning toxic residues in food and water for human and animal consumption. The benefits which accrue from the use of these substances in agricultural production programmes and in public health work are sufficiently great to warrant intensive study devoted to the development of safe systems of application and use.

In this country an outcome of the recommendations of Government-appointed Committees was the passing in 1952 of the Agriculture (Poisonous Substances) Act, which empowered the Agricultural Departments to make regulations to protect workers against health risks incurred in the use of certain poisonous substances. This Act came into operation in 1953 and the regulations have since been revised annually. The regulations (as well as the precautions advisable but not legally obligatory) will continue to need revision. Until this year (1956) these regulations were concerned with the conditions under which certain compounds falling within two main chemical classes—organo-phosphorus and dinitro compounds—could be used. This year the organo-mercury compounds are brought within the regulations for the first time, but only when they are used as aerosols in glasshouses.

In this country no official permitted limits of chemicals in human food exist although statutory limits for arsenic and lead may soon be promulgated. Under existing regulations it is forbidden, with a few exceptions, to add preservatives to food. These regulations would restrict the use of antibiotics in agriculture if residues were found in the crops or food at the time they were consumed. Unofficial limits exist for DDT (7 p.p.m.) lindane (2.5 p.p.m.) and schradan (1 p.p.m.) but these are used mainly to guide potential users. The machinery in operation at

the present time is for a Scientific Sub-committee of an Interdepartmental Advisory Committee to examine proposals for all agricultural uses of pesticides. Data of crops treated, quantities applied, times of application and residue data when available, are collected. On the basis of this the Sub-committee decides whether or not it approves the use of pesticides for the particular purpose proposed. In approving use it may stipulate the maximum application rate and the times of application in relation to harvest. The bulk of evidence is normally provided by the manufacturer, though evidence from independent bodies is welcomed where it is available. A decision may be postponed and the manufacturer advised to provide more residue data, or a temporary approval may be given on the understanding that the opportunity for obtaining more data will be used. The decisions of the Committee are conveyed to the industry and any representations they wish to make are always considered.

Perhaps it would not be out of place to emphasise again that the major causes of accidental poisoning on the farm are due to ignorance or carelessness. Too much stress cannot be put on the necessity for care in the use of many of the substances now available. Most manufacturers are only too pleased to supply full and detailed instructions on procedures for storage, precautions in use, and methods of disposal of surplus pesticides. In particular, information about time of application, weather conditions when sprays should and should *not* be used, precautions regarding access of live-stock to sprayed buildings, land and crops, and methods of disposal in relation to food or water contamination should be carefully studied and as carefully followed: If this is done, accidental poisoning on the farm should be a rare occurrence.

Summary

Poisoning in live-stock arising from the agricultural use of toxic chemicals is discussed. The communication deals with lead, arsenic, copper, fluorosis, bovine hyperkeratosis, sulphonamide toxicity in poultry, certain rodenticides, organo-mercurial fungicides, the chlorinated hydrocarbon and organophosphorus insecticides, and the hormone and dinitro weed-killers. It is pointed out that, despite the increasing use of many new synthetic pesticides, the vast majority of cases of poisoning on the farm are due to careless use of lead and arsenic compounds.

Sources of the poisonous substances mentioned, symptoms produced, *post-mortem* findings and lethal doses and/or toxic levels in tissues are given.

Brief mention is made of the legislation controlling the use of toxic chemicals in agriculture in this country and of the voluntary system for approval of new products.

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THE SPEAKER'S INTRODUCTION

Mr. J. L. McGirr, introducing his paper, said: "I must first of all thank the British Veterinary Association for asking me to present this paper and, at the same time, apologise for all its omissions. With a wide-ranging subject such as toxicology it is difficult to select topics for discussion, and even more difficult to decide what to omit. Those of you who have read the paper will have discovered that the subject matter with which I have dealt is not particularly comprehensive but I think, or at least hope, that the major substances which cause trouble to-day in Britain are mentioned.

" We tend to feel that our present-day toxicity problems are somewhat different from those with which people had to deal in the past. I do not think that this is true; most cases of poisoning are due to ignorance or carelessness and if toxic substances are used properly few accidents should occur.

" I want to mention briefly a few of what I consider to be the important points in the paper. Firstly, it should be noted that despite the increase in the number of new toxic chemicals which are used to-day, our old friends and enemies—lead and arsenic—are still the most important causes of poisoning on the farm. There is little to say about them apart, perhaps, from stressing that arsenical sprays are potentially very lethal and that accidents due to spray drift contamination are not as infrequent as one would wish.

" So far as copper poisoning is concerned, the major point of interest is that we now come across a certain number of cases in calves and pigs. In my opinion, copper supplementation of the rations of animals is being used rather indiscriminately without due realisation of the fact that copper can be quite dangerous under certain circumstances. Unfortunately, the precise pathogenesis of copper poisoning is not properly understood and one often wonders whether liver damage is produced by undue accumulation of copper, or whether the latter occurs where liver damage pre-exists.

" Fluorosis has been dealt with on many occasions in the past and has been recently reviewed. Bovine hyperkeratosis is an interesting condition; we have not seen a great deal of it in this country but with the development and appearance of so-called mucosal disease in calves in this country, the condition must be borne in mind, mainly because of its somewhat similar symptomatology and pathology. A recent report from Germany describes a mucosal disease syndrome in which a transmissible virus was found but where the complete syndrome would only be reproduced when animals had access to binder twine which had been processed with a hyperkeratosis-producing chlorinated naphthalene compound.

" So far as rodenticides are concerned it need only be stressed that all are poisons for stock and that due care should be exercised in their use The effects of organomercurial fungicides appear to vary considerably. Many seed dressings contain dieldrin as well as these fungicides and considerable care must be exercised in giving any advice about the use of excess seed grain for incorporation in compound feeding-stuffs.

" In the hydrocarbon group of insecticides dieldrin has recently received publicity because of its toxicity for birds, while aldrin gained some notoriety following an unfortunate poisoning incident in Wales where flour which was accidently contaminated was used for human food.

" The paper concludes with some general remarks on the administrative methods in operation for the control and handling of pesticides. It is important to remember that we have no satisfactory methods for detecting some of these compounds *in relicta* and that even where methods are available they are often laborious and time-consuming and raise major problems for the analyst. If practitioners require analytical evidence of the presence of toxic chemicals in *post-mortem* material they must be able to give a complete history of the case in full detail. Often the laboratory will not be in a position to carry out chemical analysis and a presumptive diagnosis will depend on the assessment of the history.

The Openers

Mr. N. M. Black, opening the discussion, said: "I would like to take this opportunity on your behalf of congratulating and thanking Mr. McGirr for his masterly survey of present-day toxicological problems. As a member of the Provisional Committee for this Congress, I must admit responsibility for suggesting the title of this paper and the name of Mr. McGirr as the best person to present it. I made these suggestions believing that Congress should have at least one paper in the nature of a survey and on a subject of really practical significance to the busy practitioner who is not always able to keep abreast of current advances in technical knowledge.

" Whilst we as a profession do not come across toxicological problems of a forensic nature involving the destruction of one human being by another, as is the experience in our sister profession, we still have many poisoning cases which require quite a lot of detective work, and on which our professional evidence will help to determine the basic cause, which in many cases may involve the payment of compensation. Our toxicological problems, therefore, are still intriguing. and the need to keep our knowledge up to date is quite evident.

" The author has achieved his purpose in such an admirable fashion that I hope it will disguise the deficiencies in my own knowledge, and afford me the opportunity of discussing the wider issues whilst not being specific on any one. McGirr is a laboratory worker, my fellow opener a general practitioner, a worthy son of a respected father. As far as my own position is concerned, I frequently occupy the side lines, and, like the usual onlooker, I often think I see most of the game.

" In this connexion I have a few words of criticism of the layman in general and some of my professional colleagues in particular. How many of us fully appreciate the amazing power of coincidence as it occurs in everyday life? How often do we stop to remember that the apparent cause and apparent effect do not invariably follow directly on each other and, in fact, need not be connected quite so obviously as appearances would suggest? Many people, layman and professional alike, are quite prepared—in fact go out of their way—in investigational work in general and toxicological matters in particular, to ignore the power of coincidence and insist that cause and effect are quite obvious when, in fact, they are nothing of the sort. Those of us at the receiving end can forgive the layman for jumping to unscientific conclusions but we have, I suggest, a right to expect that the technically educated should not fall into the same error.

" Sheep are dipped, lambs receive a normal dose of phenothiazine, a new pig meal is brought into use and deaths within a reasonable and sometimes an unreasonable time, following these quite normal events can only, in the minds of many, be attributed to what is gaily or crassly referred to as ' the obvious cause.' What I have put to you somewhat light-heartedly is, in fact, a matter for serious consideration in the interests of the maintenance of professional integrity and the avoidance of unnecessary litigation.

" I must take issue with the author on his remarks concerning the origin of to-day's toxicological problems. They arise, he says, largely from the lack of adequate facilities for the dissemination of reliable information on the methods of application and hazards attendant on the use of modern chemicals. Whilst Mr. McGirr attempts to redeem himself towards the end of his paper, I think he would have been more accurate if he had said that despite the greatly increased use of toxic chemicals on the farm to-day, the vast majority of poisoning cases are still due to human carelessness. Let me illustrate my contention by quoting a few bizarre examples from the hundreds of cases which have come to my notice.

First, there was the farmer (or perhaps more correctly the farmer's wife) who assumed, presumably on the basis that ' at night all cats are grey,' that all green powders used on the farm are bound to be phenothiazine! It was only after about 80 valuable lambs were dead that it was discovered by the investigators (not by the users) that a mixture of paris green and phenothiazine had been used. Paris green, as you no doubt know, is copper aceto-arsenite

and, of course, highly toxic. Paris green cannot be termed a commonly used chemical on the farm but it is interesting to note that two incidents such as I have just described occurred under similar circumstances on different farms within a few weeks of each other.

" Next, we have another case of mistaken identity. As you know, copper preparations are used in agriculture for their fungicidal properties, and a common preparation is a dry powder formulation of copper oxychloride for the control of potato blight. On a farm a bag of the copper fungicide was found to be split open, and being a greenish powder it was assumed to be phenothiazine and put into a half empty tin of that preparation. When, some weeks later, over 40 valuable ewes were dosed with this mixture, all the unfortunate animals died.

" An interesting side issue in this case was the fact that one of the local investigators insisted in trying to find out how much arsenic was likely to be found as a contaminant in copper preparations of this type. When the figure was eventually calculated for him, he claimed that it was high enough to be toxic to animals and thus constituted a danger to them. With great patience it was pointed out that quite apart from the obvious misuse of a *plant* product, the arsenic level was totally irrelevant to the matter in hand, and he was reminded that copper salts, which so many people seem to look upon as relatively inoffensive chemicals, can be just as dangerous as those notorious materials bearing more sinister names.

" Recently, some highly skilled detective work on the part of a practising veterinarian solved another problem which, while it did not result from mistaken identity, arose from another careless act. Three groups of sheep were dipped in dieldrin sheep dip and returned to separate fields. Deaths occurred within 36 hours and careful search of the area revealed a foot-bath in the bottom of which was about an inch of rain water. When the shepherd, who had not accompanied the veterinarian on his visit, was later asked about the foot-bath, he replied with every confidence that he left the bath empty three or four days ago and the only rain since had been a small shower, but it had been just enough to re-dissolve the residue of an arsenical foot-rot preparation.

" The last careless error which I shall describe shows the value of getting one's facts right. A practitioner, having attended a refresher course on the treatment of infertility, diagnosed a copper deficiency as the probable cause of poor breeding history on a particular farm. Looking up his notes he found that one method which had been described as an alternative to oral dosing involved the intravenous injection of ' a solution containing 1 mg. of copper sulphate per c.c., *made isotonic*.' It was subsequently claimed by those charged with the duty of preparing this solution that, in fact, the order was given for ' an isotonic solution of copper sulphate.' Examination of the suspect material indeed demonstrated that it was an isotonic solution of copper sulphate, that is, it contained 37.1 mg. of copper sulphate per c.c. As a result of this treatment, six pedigree heifers, value about £500, never again suffered under the stigma of their failure to breed.

" Errors have their lighter side. The Aberdeenshire farmer who dipped 60 ewes in what he thought was ' green-moulded DDT dip ' but which in fact was phenothiazine, had the incontrovertible evidence thrown in his face every day for several months, as his sheep's colour changed from pink, through purple to black. Perhaps it was not so amusing after all because much valuable wool was lost.

" Referring to lead poisoning, the author stresses the need for an intensive search for the source of the lead. Many of us here know only too well the amount of effort required to find the source, and how in some cases one is tempted at first to consider the possibility of hypomagnesaemia as the cause of the extraordinary excitability in more acute cases.

" At the Royal Show this year a North Country veterinarian asked me if I had ever come across ' pianola ' poisoning. On admitting that such an apparently exotic condition had not yet come my way, the circumstances were described. It appears that a general merchant invested in a rather broken-down pianola; unable to find a customer or to repair the instrument, he took it into a field and set fire to it. Many months later a group of calves, in the course of grazing in the area of the conflagration were able to pick up enough lead melted out of the pianola's ' works ' to kill themselves.

" In Ireland I was told that many a good cow had been killed by an old motor car, but not on the road. It appears that with that joyous disregard for the conventional which is such a pleasing, yet sometimes irritating, characteristic of the Irish, the old car when it reaches the end of its days is often pushed—with the minimum of effort—into the local bog, where during its final disintegration it gives up its lead-lined batteries for consumption by the local cattle.

" Regarding the treatment of lead and arsenic poisoning, a British product called Anti-Lewisite, or BAL for short, held out some hope of success in the veterinary field. BAL was first discovered as an antidote to Lewisite war-gas poisoning, and then it was used with great success against skin rashes in man induced by prolonged arsenic therapy Later, it showed promise against heavy metal poisoning such as lead and thallium. In animals, it has been very disappointing. Quite apart from its failure as a therapeutic agent it gives rise, on injection, to rather alarming abscesses I mention the failure of this product because in the quest for anything of value in such cases, we are often asked for it. As Mr. McGirr has said, there is some hope that the chelates such as calcium disodium versenate will be found of value in the veterinary field.

" Copper has already been mentioned at some length and I think it would do no harm again to stress that it is a poison. The author does a good service when he stresses the freedom with which this versatile element is used in agriculture. Reference is made to the extra care necessary when feeding copper to housed animals. I seem to recall that this is of some particular significance and that Weybridge have some interesting observations to make. Perhaps Mr. McGirr would enlighten us?

" In his remarks on sulphonamide toxicity in poultry, I am sorry that the author did not make it quite clear that the haemorrhagic syndrome has been noted in birds medicated with *normal levels* of sulphonamides, and the question of over-dosage is not always involved. The author's remarks concerning warfarin deserve widespread publicity. This fairly new rodenticide could, in my opinion, be quite rightly called a ' conditional ' poison, that is, it kills under certain rather special conditions.

" Referring to the chlorinated hydrocarbons, Mr. McGirr has disclosed something of the recent Weybridge investigations which show that dieldrin can be toxic to pigeons, with a delay of several days between ingestion and the appearance of symptoms. This is an interesting observation, and I hope he can elaborate on this point. It appears that the manufacturers of a seed dressing based on dieldrin at first believed that the preparation had what they called a deterrent effect to birds. This, of course, mightily pleased the users and conjured up hopes of a new use in the minds of the sellers, but destruction of wild birds is a different matter. Where dieldrin has been used in sheep dips, it has proved a great advance on its predecessors, and so far there has been no apparent toxic effect when properly used.

" Lastly, reference is made to the hormone weed killers. I think the author is quite right when he says that these are usually regarded as non-toxic to animals at concentrations at which they are normally applied. We cannot escape the fact that the two common preparations 2—4 D and MCPA have been freely used over a period of about ten years in this country and it is surprising to me to hear that ' cattle, sheep and pigs on sprayed land may suffer.' I must say I have no record of proved cases of toxicity, unless one includes one case which was, after all, an indirect effect. On this occasion it was alleged that the effect of weed killer on buttercups was to render them more succulent and presumably more attactive to grazing cattle during the early period of stimulation of growth before the weeds died.

" Sodium chlorate, a total killer of vegetation, has not been mentioned. Since the labels and leaflets on this product are presumably writen by specialists in plant rather than animal matters there has been a tendency to make no cautionary remarks on toxicity, or worse still, to claim that it is non-poisonous. In my experience this is not true. I

would agree that it is of low toxicity, but I have recent records of deaths in cattle from eating treated herbage, and in cats from drinking from puddles of chlorate solution.

" Phenothiazine and hexachloroethane, either alone or combined in one product, have not been covered. I almost invariably find that the deaths in sheep from so-called phenothiazine poisoning are due to dosing gun injuries. In this connexion, I would like to make a plea for a closer study of the pharyngeal region, the oesophagus and chest cavity, and less to the alimentary canal, when carrying out *post-mortems* on such cases.

" Photosensitisation affecting the eyes in calves when dosed with phenothiazine has been noted on one or two occasions, but since the essential prerequisite of several hours continuous sunshine following dosing is likely to be conspicuous by its absence in this county, we do not expect too many cases."

Mr. Alastair Steele-Bodger said: "First let me thank the provisional committee for according me the privilege of being one of the openers of the discussion on Mr. McGirr's paper. Secondly, I must congratulate Mr. McGirr on his paper; as he points out, the field of toxicity is so wide that only a representative section of the causative agents can be mentioned. I am afraid I must admit that until my interest was stimulated by reading his Review I had no idea that there were so many toxic substances in everyday use in the environment of animals. Mr. Black has succeeded in stealing some of my thunder so I hope you will bear with me if my remarks are somewhat disjointed if I leave out portions of what I intended to say.

" It was intimated that my remarks should be mainly from the point of view of the general practitioner and that my fellow opener would deal with the manufacturing aspect. Generally speaking, the manufacturer is concerned with making a substance to kill a pest while the practitioner is concerned with ensuring that it does not kill anything else. I have gone through the paper and will endeavour to stress the points most likely to concern the practitioner and, therefore, shall pay scant attention to some sections partly because of lack of knowledge and partly because I feel that this morning's repast is so rich with academic fat that we must take care to avoid any further toxic symptoms! In addition, I will include a few substances not covered by the paper.

" Firstly, lead, which appears to be the most common cause of fatal poisoning among farm stock. As Mr. McGirr has said, the source of the lead may be difficult to find, and stock owners will pooh pooh the suggestion that there is any. Confirmation by chemical analysis sometimes refreshes their memories and leads to a more diligent search. For his own peace of mind where sudden death occurs amongst calves the practitioner should always send off a kidney for lead estimation. In my own practice, since this became routine procedure, I have been surprised how frequently positive results have been obtained.

" With regard to treatment, like many others I have a stock of calcium versenate but so far I have not had cause to use it. On the question of taking blood samples while one is treating the animal with the calcium versenates, the blood picture so far as lead is concerned continues to rise alarmingly. This can go on for 10 days and then gradually it drops off in the course of 48 hours. Perhaps Mr. McGirr would enlarge on that.

" I have never recognised a case of acute lead poisoning in a dog, but this summer one case of chronic poisoning was seen. The patient was a two-year-old bull mastiff bitch belonging to a farmer. The owner complained that the bitch was losing condition and hair colour, and appeared to be slobbering more than usual. Examination of the mouth revealed a characteristic blue band 2 to 3 mm. broad, which followed the gum margin on both upper and lower jaws, and which extended right back to the molars—unlike the text-book description for the horse. The jaws were not inflamed but were very tender on palpation. On enquiry it was found that the bitch was prone to eating grass in the orchard and a lead spray had been used on the trees. We gave calcium lactate tablets daily and within 10 days the blue line had disappeared and the animal made an uneventful recovery.

" I quite agree with the author that in the case of arsenic and copper, the lack of care in their use as dips, drenches, etc., is often little short of scandalous. Death from arsenic can be slow and extremely distressing; symptomatic treatment is rather unsatisfactory and moist ferric hydroxide has not, in my hands, proved of much benefit. It would be interesting if someone could quote their experiences with sodium thiosulphate in group poisoning by arsenic. Has Mr. McGirr any evidence to show that dimercaprol is superior to sodium thiosulphate?

" From the practitioner's point of view, a further complication in poisoning by arsenic is that in cases where it is not possible to save the patient, it is also not easy by slaughtering to save the farmer's pocket. I believe the legal maximum for arsenic in food is 0.3 gr. per 1,000 and this may well be exceeded in cattle suffering from arsenical poisoning. This ruling is a delightful example of quixotic British law, since one may cheerfully eat shell-fish which may well contain 40 times more—12 gr. of arsenic per 1,000.

" I have not to my knowledge come across fluorosis in practice but I did visit some affected farms in Scotland with Professor Boddie and was made well aware of the characteristic dental lesions and the serious economic loss they may entail. The veterinary surgeons who practice in contaminated areas will be very interested in the results of the experiment being carried out in the Potteries. If the addition of fluorine alleviators proves an economic proposition, well and good, but even so would Mr. McGirr not agree that it is yet another overhead expense on the farm? When the results of the fluorosis survey are known surely the industrial concerns responsible for the contamination should not only be urged but compelled to instal more efficient trapping devices or at least pay the cost of the fluorine alleviators?

" Outbreaks of sulphaquinoxaline poisoning in poultry are not infrequently encountered in practice, especially amongst intensively managed flocks. It seems to me that in the apparent palatability of the drug lies both its strength and its weakness. The chicken's liking for it appears to cure many birds suffering from coccidiosis who will not drink water containing other coccidiostatic agents. On the other hand, during hot weather I have been called in to birds dying from too great an intake of correctly medicated water. Since there is no antidote for poisoned birds and since deaths can occur up to 14 days after withdrawal of the drug, we must hope that the folic acid inhibitors may prove successful when generally employed.

" With regard to the haemorrhagic syndrome as seen in the United States, I would suggest that it may occur in the absence of sulphonamides, but sulphaquinoxaline poisoning is practically never seen without haemorrhages. Indeed, at least one British authority regards the usual haemorrhage picture as pathognomic of sulphaquinoxaline poisoning.

" Warfarin is probably becoming the most popular of the rodenticides mentioned in the paper; although it is extremely difficult in practice to assess the value of treatment, I do think that vitamin K or its analogues can help. On four occasions where circumstantial, clinical and *post-mortem* evidence indicated warfarin poisoning deaths ceased following the administration of vitamin K and where lameness and skin discoloration were present they had resolved in most cases within 10 days. It is worth bearing in mind that slaughter of affected pigs with a view to salvage is not a wise policy since the carcases are invariably condemned and if killed for home consumption will not take salt.

" Unlike Mr. Black I believe that phenothiazine is a common cause of poisoning in stock, especially cattle. Symptoms vary from sudden death to scouring which appears to be uncontrollable and eventually fatal. *Post-mortem* lesions range from nil to an acute gastritis, enteritis and nephritis. Individual susceptibility may be responsible for some deaths, but I consider more are due to giving the normally recommended doses to already debilitated stock. Despite some evidence to the contrary, I still feel that there is much to be said for the repetition of smaller doses in heavily infested animals. It would also appear that the method of manufacture of phenothiazine has some bearing on both its effectiveness and toxicity. In equine practice there is some strong

evidence that chronic phenothiazine poisoning is a real danger. The heart is the organ affected, auricular fibrillation being a prominent symptom. The macroscopic *post-mortem* lesion is enlargement of the heart. Can Mr. McGirr tell us something of the pathology of this condition?

"In small-animal practice diethylthiambutene is a commonly used product which appears to be toxic in a number of cases. Despite accurate dosage and slow intravenous injection some dogs will go into convulsions which prove alarming and occasionally fatal.

" Nalorphine hydrobromide is the specific antidote and against the normal sedative action it is extremely effective if somewhat short acting but it does not seem to have any effect on dogs which develop fits. These may occur at any time from the injection and usually fade away in 6 to 12 hours and one is simply left with a feeling of irritation that operative procedures have had to be postponed. When fatalities have occurred it is generally within three hours of the injection. One such case occurred after a caesarean section at which five live pups were produced under light ether anaesthetic. After the operation the bitch seemed all right for an hour or so and then convulsions started and, despite the use of nalorphine hydrobromide and other more heroic measures, death ensued. I would be interested to know if others have experienced this syndrome and what measures they take to counteract it. It would also be of interest if we could be told whether the action of nalorphine as far as antidotal properties are concerned is chemical or physiological.

" With regard to the hormone weed killers it is encouraging that some are supposed to be non-toxic. Mr. McGirr suggests that certain toxic weeds may become especially attractive to pigs after hormone applications. I would like him to enlarge on this point since I understood that workers in America had shown fairly conclusively that such was not the case. Since experiments with 2—4 D demonstrate that this substance is not a cumulative poison and that chicks cropping sprayed grass show no reduction in weight, could anyone explain why adult birds under the same conditions show such a marked drop in egg production, and the eggs such low fertility and hatchability?

" As far as the organo-mercurial fungicides are concerned, I would like to ask Mr. McGirr from the point of view of treatment if he can give an opinion on the comparative efficiency of dimercaprol and sodium formaldehyde sulphoxylate? The other point he brought up with regard to seed dressing, does he consider that cows and pigs are particularly susceptible to mercurial poisoning? If so, would it not be wise for practitioners never to recommend the feeding of dressed seed to these animals?

"The organo-phosphorus and dinitrophenol groups of insecticides are extremely efficient at the specific purpose for which they are employed, and it is fairly certain that large scale spraying with them will become a routine procedure but they are also among the most dangerous used on the farm. Unlike lead, which is the most common cause of death by poisoning and which usually only affects one or two individuals in the exposed group, the modern spray insecticides often poison all the animals exposed to them. When faced with suspected cases of spray poisoning the practitioner is often at a great disadvantage. He may only be able to ascertain the trade name of the spray used, and it may be difficult to obtain precise information regarding the spray's chemical composition. In many instances further information is required to determine the active principle. A search of reference books is often needed to discover the antidote and having got that far frequently the available supply is only sufficient to treat one or two of the affected animals at the recommended dosage rate.

" To quote an example: I was called in by a farmer who informed me that in a small group of fat Hereford bullocks one was dead and another frothing at the mouth, grinding its teeth and kicking at its stomach in obvious pain. I learned that brussels sprouts had been sprayed in the next field. I was told the name of the spray used—it conveyed little to me and even less to the harassed owner, although he did wax eloquent but unprintable on the subject of sprays and spraying contractors! The contractor informed me that the spray contained active ingredients equivalent to 66 per cent. (Bis dimethylamine phosphorus) anhydride Schradan—as you can imagine this was most enlightening! Eventually I was told that atropine sulphate was the antidote and that it should be administered intravenously, the dosage rate being 1 gr. per 1,000 lb. I could not help feeling that this was a somewhat drastic remedy, but none the less duly dissolved ten 1/100 gr. tablets in 10 c.c. of water and injected. Strangely enough the response was most gratifying and according to the owner it was difficult to decide who looked the more surprised, the bullock or I! Afterwards it did not seem at all inappropriate that when scientific proof had to be produced the only laboratory I could find to tackle the job was at the Imperial Bureau of Chemical Warfare. It is perhaps worthy of mention that at a later date I gave 1 gr. of atropine intravenously to an apparently healthy ' knacker ' cow weighing 1,036 lb. and she died within eight minutes of respiratory failure.

" I have painted a rather black picture, but such has been my experience and others in practice can tell the same sad tale. Mr. McGirr stated in the introduction to his paper that ' to-day's toxicity problems are, from the viewpoint of the clinician and toxicologist, due to some extent to the fact that reliable methods for the diagnosis of poisoning are not always available.' This statement, in my opinion, puts in a nutshell the unenviable position of the practitioner when called in to a suspected case of spray poisoning.

" Subsequent to the example of poisoning that I have just described, I obtained from the main contractor in my district a list of the most commonly used sprays and their antidotes, if any. The list consisted of 44 substances, six contain arsenic and 11 contain copper and/or mercury, while atropine sulphate was the antidote to the remaining 27.

"In view of the dangerous nature of atropine in large doses, one is chary of using it in an individual case in the absence of strong circumstantial and clinical evidence. Some reliable method of field diagnosis would, in many instances, be a veritable boon. In the event of one's client making a claim, his veterinary surgeon is expected to supply the necessary proof of poisoning. Since the manufacturer's laboratory can hardly be approached I feel that it would be a distinct advantage if a directory could be compiled giving the whereabouts of laboratories capable of carrying out the necessary tests which must often be done shortly after the onset of symptoms or death. In a wider sphere I feel that the time is ripe for fresh legislation regarding sprays and spraying in general. Some of the sprays used may, under suitable climatic conditions, remain toxic to stock and perhaps children for up to 30 days. I consider that signs should be prominently displayed in fields so treated.

" On the same theme, I have learned from bitter experience that arsenical haulm destroyer can be sprayed on potatoes without any warning having to be given to the owners of stock in adjacent fields. Such a situation surely calls for speedy legislative action."

The General Discussion

Professor G. F. Boddie (Royal (Dick) Veterinary College, Edinburgh) said that he had enjoyed reading Mr. McGirr's paper very much indeed. There was in it a great deal of important information presented with an economy of words which made the reading of the paper a real pleasure. Running through the paper there was a most important message which perhaps he could be permitted to emphasise. While clinicians must still be prepared to encounter the old toxicological problems as presented by substances like lead and arsenic, they must be prepared to elucidate the new problems created with fiendish ingenuity by the manufacturing chemist. He wondered if Mr. McGirr would be prepared to express any opinion as to how far the use of chemical spraying for various purposes could proceed without seriously endangering the balance of nature.

Perhaps he might be permitted to underline one or two points in the paper. With regard to fluorosis, Mr. McGirr pointed out the limitations on the value of herbage samples in the differential diagnosis of fluorosis and he thought the importance of the time factor in relation to herbage samples needed emphasis. For instance, a five-year-old cow showing the lesions of dental fluorosis ingested the fluorine compound

which damaged her teeth during the age of adolescence when the permanent teeth were being formed. The fluorine content of the herbage she was at present grazing had no relevance whatever to her present dental condition. He would congratulate Mr. McGirr on the last sentence of the section dealing with fluorosis. It was quite the most concise presentation of the problem he had ever read. The concluding clause of this sentence was very important for there had been an unfortunate tendency to exaggerate the economic losses arising from fluorosis. In many instances malnutrition in its widest sense was far more significant than dental fluorosis. There had been a number of publications from various parts of the world, particularly from across the Atlantic, which appeared to him to place undue emphasis on the importance of lesions of dental fluorosis in the incisor teeth. The mere fact that lesions of fluorosis were found in the incisor teeth of cattle and sheep was no justification for failing to make a complete investigation which might very well reveal other important factors leading to debility.

At the 1947 Congress in Edinburgh a description was given of the poisoning of stock in Scotland by the burning of war stores. He did not think there was any doubt now that the condition then described in some detail was what was now designated as hyperkeratosis so that the only thing they failed to do in the outbreak was to devise a name for the condition, although the farming community had their own name.

In 1947 they were concerned with the possible toxicity of red squills for stock which was then used as a rat poison, it was now known as a rodenticide. (They were inclined to look down on their ancestors for their pedantic pomposity, were they any better when they called a rat poison a rodenticide?) To-day they were concerned with the toxicity of newer inventions in the realm of rat poison. Warfarin was mentioned and it was an interesting example of deliberately using toxic amounts of a substance which in a slightly different form was widely used as an anticoagulant in modern medicine. Perhaps a lesson could be learnt from this in that it seemed to show how narrow was the dividing line between beneficial pharmacological compounds and dangerous toxic ones. That brought him to the final point he would like to make: was it then surprising that new drugs introduced without adequate trial were found to have undesirable toxic actions which were never even mentioned when they were first introduced?

Mr. W. H. Parker (Wolverhampton), said that he would like to echo the words of appreciation of Mr. McGirr's excellent paper. Perhaps the most astonishing thing he had heard that morning was that the gentleman for whom he had always had the greatest respect, especially for his erudition when he (Mr. Parker) was a student, was unable to name a disease, especially when the Americans had such a highly descriptive name for it—X disease!

He would like to raise the question of copper again because it had been given so much emphasis by the opening speakers (he would think an excessive emphasis for a poison which he had not regarded as very common, at any rate in this part of the country). He thought it needed emphasising that a number of manufacturers of other drugs—he was thinking particularly of phenothiazine—included copper in their drugs. Why, he did not understand, because the areas of copper deficiency were fairly restricted, whereas worm infestation occurred throughout the country. There was further the unfortunate fact that the advice of research workers on the dose of phenothiazine was invariably greatly in excess of the advice given by the manufacturers of the drug, and there was a risk of copper poisoning if the proper dose of phenothiazine was used instead of the one recommended by the manufacturer.

On the question of sulphonamide poisoning, it was stated in Mr. McGirr's paper that the haemorrhagic syndrome had not been recorded in this country as occurring without the use of sulphonamide. He had certainly come across at least one case this summer and he suspected that it was occurring more frequently for at one period for a whole fortnight the haemorrhagic syndrome became more common than any other condition in the *post-mortem* room. The point had been made that in hot weather the birds had a greater drinking capacity, but there had not been any hot weather this summer and there had been more haemorrhagic syndrome than ever before.

In his paper Mr. McGirr stressed that fluorine in this country was not due to the presence of natural fluorine in water but he would point out that there had been quite a number of cases where fluorine damage had resulted from the contamination of water by factories and that aerial contamination was not the only means by which fluorine was disseminated. At one farm he had not the slightest doubt that the major cause of the poisoning was the water supply which was used as an effluent from a factory. Mr. McGirr rightly stressed that carelessness was too often the cause of poisoning on the farm, but he thought that in the matter of arsenic that was hardly fair to the farmers these days. When arsenic was used as a sheep dip in a controlled space and was then allowed to be distributed in such a way that it caused poisoning, he agreed that that was carelessness, but it seemed to him an unmitigated disaster that a few years ago the comparatively harmless substance, sulphuric acid, ceased to be used for killing potato haulms and arsenic was introduced in its place. It was one thing to put arsenic in a confined space for a sheep dip but quite another when a deadly poison was disseminated round the countryside in an indiscriminate fashion—and he did not see how anyone could control the area where spray would land in a 20-acre field. The danger was ceasing to be a matter of carelessness and becoming one of inevitable hazard.

Mr. J. D. Blaxland (Weybridge) said that he had only one short comment to make on Mr. McGirr's most interesting paper and that was in connexion with the use of dieldrin-dressed corn. The Congress might be interested to hear that the same dieldrin-dressed corn which Mr. McGirr mentioned as having proved lethal to pigeons had proved lethal to pheasants in another series of experiments. Unexplained deaths among pheasants on a number of estates during the spring of this year prompted these experiments. It seemed to him that the use of this preparation as a seed dressing constituted another example of man's interference with nature. Once again they would have to decide whether gain or advantage to man justified the continued use of this preparation despite its almost certain danger to the natural wild life of the country.

Mr. D. W. Jolly (Cooper Research Station, Berkhamsted), added his congratulations to Mr. McGirr on his paper. He wished to refer to the chemicals which Professor Boddie described as coming from the " fiendish ingenuity " of the chemists. The toxic hazards of these chemicals was very much appreciated by the chemists, and it was his job, as a member of a rapidly expanding branch of the veterinary and medical professions, to assess the toxic hazards to live-stock of these new chemicals. Dangerous chemicals were discarded, but some chemicals, although toxic, were so efficient, that their value to agriculture outweighed their toxic hazards. The pharmacology, and conditions of use, of these chemicals, were studied, so that full information could be made available to the profession, together with recommendations as to antidotal treatment.

A chemical which had been mentioned several times was dieldrin, which had proved of outstanding value in the treatment of maggot flies on sheep. An immense amount of work had been done on its toxicity in this country, and in the United States, but much had been published in journals little known to the veterinary profession. Toxicologists had a language of their own, but so far no journals of their own and toxicological information was scattered throughout a vast range of scientific journals. Mr. Jolly spent much time going through journals in a search for toxicological information on new insecticides and new drugs generally. One of the reasons for Mr. Steele-Bodger's justifiable criticisms that the profession did not know enough about these new chemicals, was that, although the work had been done, it was often published in some journal, usually a medical journal, and this information did not become known to the veterinary profession until months or years later—if at all. He hoped that those members of the profession in the same line of business as himself, would use THE VETERINARY RECORD, or some other journal which was readily available to the profession, for publishing their work.

Mr. Steele-Bodger said that phenothiazine toxicity in

calves was manifested by diarrhoea. Mr. Jolly was surprised by this statement because some years ago he gave large quantities of phenothiazine to young calves in an endeavour to induce toxic symptoms. Some 200 gm. of phenothiazine were given by stomach tube to young calves and a toxic reaction developed in which there was incoordination which seemed to be of cerebral origin. The calf decided to lay down some hours after the dose, and refused to get up again. There have been published reports of this type of reaction, in which an animal developed inco-ordination and became recumbent after phenothiazine dosing, but diarrhoea was not observed in these cases. He would like to know if Mr. McGirr had any experience of phenothiazine toxicity. Another toxic reaction of calves associated with phenothiazine, was that of photosensitisation. As sunlight was the inciting factor, this type of phenothiazine intoxication was rare in this country. To his knowledge there had only been two cases, both of which were in Anglesey.

One last point concerned the use of atropine to combat poisoning by the organo-phosphorus group of insecticides, to which Mr. Steele-Bodger referred. He showed that very large doses of atropine were required. This was generally accepted, but Mr. Steele-Bodger had put his finger on a most important point, namely that one must be sure that the condition was that of organo-phosphorus poisoning. It was apparent that the very large doses of atropine required to alleviate the acetyl choline poisoning, which characterises this type of intoxication, would be dangerous in themselves if a mistake was made in the diagnosis of the condition.

Mr. S. L. Hignett, B.Sc. (Wellcome Veterinary Research Station, Frant) said that he also would like to thank Mr. Mr. McGirr for his most valuable paper and the introduction to the paper that morning. He would also like to pay tribute to the openers. In his opinion it was not often that two openers gave such a rare treat. He found it very difficult to believe that there had been no collusion, the remarks of each speaker seemed to him to be absolutely complementary.

He would like to refer to the section on copper. He was very interested in a report by Bull on a condition which he had encountered in Victoria (Australia), in which he appeared to come up against copper poisoning in sheep apparently related to a very low molybdenum intake, and he would like to know if Mr. McGirr had reason to believe that anything similar was likely to be encountered in this country. Also dealing with copper, he must complain that Mr. Black scooped his story; as the mentor of the unfortunate veterinary surgeon who gave the wrong copper solution to the even more unfortunate cattle he thought he had prior right to that story! Following on that he would like to stress (Mr. McGirr had not touched on this) the danger of giving copper, particularly if it was administered intravenously, to animals which in fact had not got low blood copper levels. In the last sentence of that section, Mr. McGirr said that a factor which might be made clear was the difficulty of ensuring that copper added to meals was adequately and evenly distributed throughout the entire batch. He knew that Mr. McGirr had a great deal of information about that particular point, and he would ask that he gave a little of that information when he replied. This, of course, was a matter which could be covered more adequately at the November conference on feed additives. (He made no apology for taking a second opportunity of advertising that conference.)

In connexion with bovine hyperkeratosis or X disease. Dr. Ayalon of Israel when he was in this country recently said that he had had experience of this particular problem, and he did emphasise that it was only certain brands of lubricants which contained chlorinated naphthalenes in such quantity that they were likely to cause trouble. He had a very frightening story to tell about this syndrome and the enormous losses which could result from small amounts of lubricant dripping off agricultural implements on to crops in the process of conservation.

Finally, rather by way of a leg-pull, when referring to zinc phosphide, Mr. McGirr said that " this was an efficient rat poison but was dangerous for all other farm animals as well! " As a farmer he regarded the rat as an interloper to be exterminated ruthlessly and not to be considered as a farm animal at all!

Mr. K. D. Downham (Cirencester) congratulated both the presenter of the paper and everybody who had spoken so far, but he thought one or two things should be emphasised.

During the past week he had had two experiences on a farm which showed what a very great danger owners of live-stock were experiencing through the possibility of these very valuable drugs, for certain purposes, being used in the hands of people who did not understand their potential danger. One was the use of drugs and additives in food. Drugs might be very good in normal conditions but personally he thought people should be prevented by law from adding any toxic substance, particularly if it might have cumulative effects to foodstuffs for animals. That was his own opinion. It was more serious that many of these products were poisons. Very often they were used by people poorly educated who did not read very carefully the instructions. Their effects varied very considerably, as many of the speakers had shown, with the climate, for instance, with substances added to drinking water, there might be two or three wet days or two or three fine days and the intake of water increased or decreased accordingly. He had in this last week had evidence of that sort. He thought more stress should be paid by all concerned particularly by the manufacturers and veterinary surgeons with experience, and all deaths which occurred after the use of these drugs should be recorded. There were often few symptoms shown in birds which died, but the total deaths of stock which had been subjected to food containing poisons should be collected and should be in the hands of competent people.

The other point was the use of arsenical sprays on farms. He recently saw on a Saturday morning a field of potatoes being sprayed with an arsenical preparation and in the next field a flock of very valuable sheep. He knew that the owner of the sheep had spent a great deal of time in keeping them healthy and there was risk of heavy contamination from the spray on to their field. He rang up the owner whose wife told him he was doing all he could. It was Saturday afternoon and very difficult to make arrangements to move them and in the meanwhile the damage could have been done.

People had said that the veterinary profession was not concerned with the detective side of some of these poisons, but he had had experience where it had affected not only the animals but the owner.

A farmer was leaving his farm and collected all his old tins and thought he would make the place a little tidy for the next tenant, and he washed some " empty " tins in a cattle trough. The incoming tenant brought a number of young stock and put them in that particular yard and five were dead in a very short while. They found it was arsenical poisoning. The sad sequel was that unfortunately a very unwise police sergeant went to the old farmer and put him through a third degree questioning and the old man was so worried that he shot himself. All this happened because the old man did not realise the importance of destroying after use such things as containers of arsenical sheep dip.

His third point was that he considered the profession was in a very responsible position and should obtain all possible information about new preparations and have it put in a readily available form. The literature was so vast that one could not keep in touch with it all, but perhaps the Association could produce one of its excellent leaflets or booklets with the accumulation of evidence about the use of these new drugs, and how the veterinary surgeon could help and warn and advise on preventive medicine which was their most important task.

Mr. A. J. Wright (Macclesfield) said that he would like to add his thanks to those of the previous speaker for the very enjoyable morning on an interesting topic about which many of us knew so little. The main reason he was speaking was to re-emphasise the danger of the arsenic sprays and he wondered whether this Association or profession might not send either a resolution or statement to the powers that be to point out that there should be labels more prominent and other ways of warning farmers of the dangers of these arsenical preparations which were being so widely used over the countryside. In a recent case of arsenical poisoning in calves in his practice he asked to see the

container: it was a five-gallon tin containing 98 per cent. W.V. sodium arsenate, and one could hardly read the weak stencilling on the tin stating what it was. The farmer flung these tins about and he was certain that the agricultural community did not realise the terrific danger that there was in these cans—five-gallon drums were often left lying about the yards.

The profession should realise the danger and it was their duty to go to the proper authorities to see if something could be done to show the farmer the potential danger.

The only other point he would make was on the question of DDT which was passed over very lightly in the paper. It was not generally toxic but everybody had experienced disastrous results due to the individual sensitivity of certain dogs to this preparation. Lead had already been mentioned and the very great difficulty of tracing the source in many cases had been emphasised. Perhaps the following experience might be of help to some members who might come across the same type of thing. A storage building was being made into new calf pens, the fittings were all tubular and no paint could be found, but eight calves were lost and the laboratory analysis and symptoms pointed to lead poisoning. For some time the source of the lead could not be found, but after some weeks while attending the remaining calves, which were suffering from chronic lead poisoning, he noticed some of the old paint had flaked off the old sproutings at the top of the building and had dropped into the outside concrete yard and the calves had licked it off the ground.

Mr. J. C. Beach (London) said that he understood that the quantitative determination of lead in tissues was rather lengthy and laborious, also that the toxic levels of lead in these tissues might sometimes be very close to the normal levels and he wondered if Mr. McGirr could say what precautions might be necessary to avoid accident contamination of samples sent for analysis. One heard of cases where kidneys were wrapped in newspaper and contaminated from the newsprint. How should they be sent? He was thinking of cases where the amount of tissue was small, kidneys and livers from poultry, livers and kidneys from budgerigars. He would like some advice on that particular point if Mr. McGirr could enlighten them.

Col. G. V. Short (Wilmslow) wished to add his thanks to the previous speakers, and to the author of one of the most valuable papers so far read at the Congress. It emphasised a principle which should be obvious but was, in fact, frequently ignored. For many years farmers had demanded of the chemical industry compounds of greater potency, specificity and duration of action against plant and animal parasites. He thought that it was agreed that such compounds had been provided. But generally it might be said that compounds of such increased potency were intrinsically more toxic, and required an increased responsibility in their use commensurate with their powers. The rational use of compounds, natural or synthetic, prophylactic or therapeutic, in the control of pathogens is possible only on the basis of the selective toxicity of these compounds. In this connexion one naturally thought of Albert's classic work. Research in this field, directed towards preparing or amending compounds of increased toxicity to the parasite and decreased toxicity to the host, had not yet arrived at the ideal of maximum toxicity to the one with complete harmlessness to the other, nor was it likely that this ideal could be attained because of the biological systems involved.

In dealing with the examination of allegedly toxic material, he would endorse Mr. Jolly's remarks. It was essential for the peace of mind and confidence of the practitioner and the farmer that those in this particular branch of the profession should be able to give as much help as possible. This could be done only if samples of the material thought to be involved were saved for examination. They had all heard of empty tins of well-known farm remedies being used to store noxious substances, and it was usually possible to find out what they were. But it was salutary to be humbled occasionally. Some samples taken from phenothiazine tins had defied analytical skill and were now museum specimens. Most cases of toxicity were due to gross carelessness. Mr. Downham's example of a farmer's potato spraying proving fatal to his neighbour's sheep down wind cannot be otherwise explained.

Mr. Wright had referred to the general ignorance among the farming community on toxicity. It should be the responsibility of the National Farmers' Union, aided however possible by the profession, to see that their members understood that a potent compound misused is a toxic compound.

He would like to ask Mr. Steele-Bodger for further details of the chronic phenothiazine poisoning in horses, with auricular fibrillation of the heart, and also of phenothiazine poisoning in cattle. Did this refer to adult cattle or calves? Recent reports of such poisoning in adult cattle had not been supported on investigation, nor did there seem to be any published evidence of its incidence.

Mr. Parker had questioned the *rationale* of adding copper salts to phenothiazine. The reason was to counter the anaemia resulting from helminthiasis. Gordon, in Australia, had shown that an average infestation of 1,000 female *Haemonchus contortus* in sheep suck about 40 c.c. of blood daily from the intestinal mucosa, and that the punctures made may bleed for up to seven minutes afterwards. It is thus rational to couple restoration of haemoglobin with removal of the helminths.

Mr. Downham had spoken against the use of food additives. Their use was surely justified by the reduced livestock loss from suboptimal growth rate, and food conversion, or from disease, that had been shown to follow their intelligent use. Toxicity from premedicated foods was almost invariably due to carelessness in mixing.

Mr. Steele-Bodger said that Mr. Short asked about phenothiazine for horses; he mentioned it because he had been given to understand that it was now a fairly recognised condition and he mentioned that he hoped that some of those engaged in practice could enlarge on it. Looking round he saw that there were not many horse practitioners present. The phenothiazine poisoning was not only in calves, he mentioned cattle, but one case in particular was a three-year-old Friesian bull which died 12 hours later. A very careful *post-mortem* was carried out and the lesions were nil. It might have been coincidence, he did not know, but a week later when this man, despite this warning, dosed some 18-month-old heifers they started to scour very violently. One other case he could quote was of 18 attested Ayrshire heifers of about 18 months old who were in a disgraceful condition, some were almost recumbent. They were sent to the knacker *en bloc*. The knacker was fairly enterprising, and he could see that there was no value in slaughter so they started to drench with phenothiazine. Four of those receiving the recommended dose were dead within 48 hours, those who received half the dose died in the course of the next fortnight, scouring themselves to death, the only ones which survived were those who were given minute doses daily.

The Reply

Mr. McGirr, in reply, thanked all those who had spoken for their kind remarks about the paper. In particular, he thanked the two opening speakers not only for their nice remarks but also for their excellent addresses; they had indeed made a good job of covering the subject.

He had made some notes of the main points raised by the different speakers. First of all, Mr. Black had mentioned the difficult problem of co-incidental happenings which frequently lead to trouble in toxicological field cases. He thoroughly agreed that one must not jump to the unwarranted conclusion that a time co-relationship need necessarily imply a causal relationship between two events.

With regard to Mr. Black's remarks about the dissemination of information, he agreed that some information on the majority of toxic substances was usually available somewhere; unfortunately, it was not always in easily obtainable form. One of the big problems was in the use of trade names. Not only was it necessary to find out the nature of the active principle in the trade material, it was on occasion important to have information about the method of formulation, and the substances used as excipients, suspending or emulsifying agents, etc.

Much had been said by Mr. Black and other speakers about copper, and he was in full agreement with those who stressed the dangers of using copper intravenously. In his

opinion copper should never be used intravenously in any animal unless there was a precise diagnosis, or one was absolutely satisfied that the animals to be treated were suffering from a hypocuprotic condition. If copper was used without that safeguard sooner or later animals would be killed.

He agreed that sulphonamide toxicity in poultry did not necessarily occur from overdosage, but little was known about why poisoning occurred occasionally with the usually accepted dosage rates.

So far as dieldrin was concerned, a considerable amount of work had been done in the United States and the wild life protection organisations had shown that it was highly toxic to many game and wild birds. As little as a milligram a day could cause toxic symptoms and death in some species.

On the question of hormone weed-killers he had, he thought, expressed himself badly in the paper. He did not mean to imply that these weed-killers were toxic *per se;* they certainly were not when used at anything like the recommended concentrations, but under certain circumstances they did react on weeds, notably ragwort, in a fashion which rendered them particularly attractive to stock.

It was difficult to assess the value of treatments for lead poisoning because many of the animals which were treated would recover spontaneously. It was true that with EDTA treatment there was a rise in the level of lead in the blood but kidney levels did not seem to increase.

Mr. Black had raised the question of material for lead estimation. At Weybridge kidney cortex was the tissue of choice from bovines because high liver values could be found in apparently normal animals—with a suitable history a kidney cortex value in excess of 10 p.p.m. was good presumptive evidence of lead poisoning. Any material for toxicological examination should be sent in chemically clean glass vessels if possible; unsuitable wrappings might contaminate specimens with metals such as lead or copper.

Mr. Steele-Bodger had mentioned the use of sodium bisulphite for the treatment of arsenical poisoning. He had had no experience of this form of treatment.

Professor Boddie had made some remarks about upsetting the balance of nature with increasing use of pesticides. The question was difficult but the Zuckermann Working Party had been unable to find any evidence of such an upset in this country so far. An instance of the sort of thing that could happen occurred in Ceylon last year. Dieldrin was being used for malaria-control purposes, and due care was exercised so far as the human population was concerned, but village cats were poisoned in large numbers. The result was that the authorities were faced with dealing with a serious plague of rats with all their disease-carrying propensities. So far as fish were concerned it might be noted that dieldrin, because of its water-solubility, was a greater menace than DDT.

Professor Boddie had discussed the effect of malnutrition in the development and severity of fluorosis. Fluorosis, like many other conditions, was not nearly so severe where food of a high nutritional standard was available for the animals exposed. It should also be noted that recent Weybridge work indicated that co-incidental hypocuprosis was responsible for a considerable proportion of the poor thriving in some areas where the farmers thought all their troubles were due to fluorine.

Mr. Parker had mentioned the question of industrial contamination of water with fluorine. There was no evidence of this in Britain; it should be noted that cattle can apparently drink water containing 5 p.p.m. fluorine without ill-effects.

Mr. Jolly had made an important remark in relation to availability of information about pesticides. Mr. McGirr believed that the World Health Organisation in Geneva was going to produce a yearly bibliography of world literature on pesticides. He understood that the U.S. Public Health Service Memorandum on Economic Poisons would be reprinted by W.H.O.

Mr. Hignett and other speakers had raised the question of efficient mixing when trace drugs or chemicals were incorporated in feeding-stuffs. This was an important problem and it did not seem to be generally appreciated that mixing to produce an even distribution of something like copper sulphate in feeding-stuffs was difficult.

The recent work on the value of synergistic mixtures, *e.g.*, coccidiostatic drugs in poultry foods must certainly raise very serious problems for manufacturers if such mixtures came into general use. The even mixing of drugs at levels of a few p.p.m. into large batches of compounded feeds must raise many technical difficulties.

The Chairman (Mr. W. L. Dwerryhouse), thanked the speaker for his paper, and the openers for their interesting contributions.

Common Diseases of Cage Birds and Other Less Usual Pets

OLIVER G. JONES

Introduction

UNDER the title of this paper, it is proposed to discuss only those cage birds or other unusual pets that the public are likely to purchase for their own pleasure. Clearly it would be impossible to do more than this, or to include more than the common ailments, in a comparatively short paper. Thus there will be omissions obvious to many of you. Such species of bird as the pheasant, partridge, pigeon, duck, goose, etc., will not be mentioned. Discussion will be limited to the parrot, budgerigar and canary, and to hamster, guinea-pig, tortoise and monkey. There are many authors better qualified than I who have already published works dealing with many aspects of health and disease of birds and small mammals, and in this connection it would be most improper, I feel, however, for me to proceed further without paying tribute to the work in this direction carried out by the great Henry Gray. Gray published, in 1936, "The Diseases of Cage and Aviary Birds"— a paper read to the Central Division of the B.V.A., on December 5th, 1935. Although 20 years have passed, Gray's observations are still valid, and at most we can only add a little modern knowledge of disease and therapeutics. Another who should be mentioned is Dr. Tom Hare. It is no secret that it is he who should be standing here to-day to give you the benefit of his vast experience and knowledge of cage birds.

To my mind it is important to mention here that the writer is a clinician: the object of this paper is to put before clinicians some observations of a fellow clinician, with some interpretations of symptomatology. Whilst the writer admires and respects the pathologist, interpretation of *post-mortem* findings is sometimes much easier than diagnosis of disease in the live creature. Many pathologists have published critical examinations of thousands of *post-mortems* of cage birds: few have ventured to point the moral.

Generally speaking, pet owners are considerate towards the dog and cat; they have, in some directions, considerable knowledge of the ailments of these animals, supported by lay text-books and popular press articles. The diet and housing of dogs and cats are a matter of concern to them, even though these matters may be taken too seriously at times —not necessarily a good fault. But when the turn of the cage bird or small mammal comes, the owner's knowledge of these creatures is frequently sadly lacking. Housing is, apparently, simply a matter of buying a cage; diet a matter of buying packeted food. If illness occurs, it is then the owner turns to the veterinary surgeon, who is frequently confronted with a situation that baffles him or her. The teaching schools must shoulder some responsibility for this latter situation. In view of the great numbers of cage birds and of small mammals kept in this country it must be admitted that there is a need for veterinary attention which, to date, has been largely neglected. The general principles of health and disease apply equally to birds and small rodents as they do to cattle, horses, sheep, dogs and cats. The only notable difference is that, by and large, when disease strikes these tiny animals, it does so very rapidly and, frequently, fatally. Only critical and immediate observation of symptoms, with rapid and sympathetic treatment, can be successful. It should be remembered at all times that the physiology and metabolism of these small creatures is such that they are extremely susceptible to shock both physical and mental, which means that handling should be minimal and preferably carried out by the owner.

It has been the writer's experience, when trying to diagnose and treat common diseases of cage birds and strange pets, that great attention should be paid to housing and diet. Precise requirements along these lines have been described by numerous authors, but at all times great attention should be paid to scrupulous cleanliness of food and surroundings. No food should remain on hand longer than 24 hours, and should be carefully inspected, before feeding, for dirt and dust, moulds, insects, sourness, and perhaps most important of all, rodent faeces. One is aware of the frequency of gastro-intestinal infections in birds and small mammals directly attributable to infected food frequently purchased in good faith; more serious is a habit amongst less ethical commercial firms of using "sweepings" for pet foods. This is courting disaster. Cages and boxes should be thoroughly cleaned daily and all should have removable floors capable of thorough disinfection. If this is not possible, a readily removable floor covering such as newspaper, should be employed.

Whilst the subject does not come within the title of this paper, the maintenance of health by hygiene and preventive medicine is really far more important than the treatment of the sick. The latter is so bristling with practical difficulties that it is best avoided by scrupulous attention to the former.

In passing on to the treatment of the common diseases of cage birds and some other unusual pets, no attempt is made to cover all diseases. No attempt, either, is made to discuss detailed pathology or bacteriorology of the diseases, which is the province of laboratories and laboratory workers and has already been recorded. The diseases to be considered have been decided upon as the result of analysing the many hundreds of telephone calls and letters received weekly by the Zoological Society of London from veterinary surgeons and/or the pet-owning public. The list thus compiled includes a very fair cross section of the problems faced, and this seems to be the fairest method of representing the title "common diseases." For other, less common diseases, refer-

ence should be made to other authors such as Ward & Gallacher, Blount, etc.

CAGE BIRDS

The commonest cage birds are the parrot, parakeet (*e.g.* budgerigar) and canary. The former are psittacenes and the latter passeriformes.

The Parrot Family

The commonest forms of parrot are the African grey parrot, the green parrot, and the sulphur-crested cockatoo. They are medium-sized birds about 12 to 16 inches long, with or without a crest on the head. There are larger parrots called macaws and amazons which come from South America. The African grey parrot is perhaps the commonest African species, whilst Australia gives us the cockatoos, with their characteristic crests, for example the all-white sulphur-crested bird with the bright yellow crest. Equally, from Australia come the smaller parrots, or parakeets typified by the budgerigar. The wild budgerigar is green in colour, but selective breeding has produced a wide variety of colour mutants. Similarly the canary, a close relative of the sparrow originating in the Canary Isles, was originally buff-green or yellow-green in colour.

Before commencing upon a discussion of the common diseases of these birds, the writer would like to suggest a routine for examination of the patient preparatory to making a diagnosis. Assuming the bird to be brought to the surgery, the writer agrees with Ratigan, that the bird, in its cage, should be put aside for a few minutes to settle down after its journey. For preference the cage should be covered over with a cloth. When this is removed distant examination will reveal:

1. *Posture.* An upright perching attitude shows physical strength. When weak, the bird will squat down on the perch, or at worst, be unable to perch at all and will be sitting disconsolately on the floor of the cage.

2. *Pain.* This is indicated in a variety of ways, including stretching and crouching, gaping, throwing the head back, shaking, and a rocking motion on the perch.

3. *Condition.* This will be reflected in the plumage which should be sleek and smooth. Disease is shown by ruffled plumage and staining on vent feathers which will appear straggly and matted. Physical movements will be alert and bright in the fit bird, and restricted and lethargic (on stimulation by noise), in the sick bird.

Close examination from outside the cage will reveal presence or absence of discharges from the eyes or nares, deficiencies in plumage, rapidity of respiration, blink speed either rapid or sluggish. Sometimes in air passage infections, wheezing will be audible. At this point it is desirable to observe the floor of the cage for general hygiene and for faecal material to assess the proportion of pure faeces to white urates, or to assess the colour of either, plus or minus the presence of blood. At the same time a general examination of food will show whether inferior grain is being fed, or if the food is stale and dirty. A closer examination of vent feathers is now possible, together with observation of the legs for coarse or inferior scaling, irregular formations, swollen joints, and the state of the claws and beak.

It is most important that critical distant and close examinations be carried out, since the golden rule always is to handle the bird as little as possible, and when this is necessary to get the owner to do it.

Handling.

In the case of parrots, thick gloves will be necessary in many cases, and even the smaller species can still inflict a painful bite. In my experience it is best to hold the whole bird, gently but firmly compressing the wings to the body, with the patient on its back. In this position the animal may be examined digitally for skin abnormalities, the abdomen palpated, medicines administered, injections carried out, cloacal swabs taken, lotions applied, etc. Avoid excessive hand pressure on the thorax since rupture of the air sacs is not unknown from this cause. Too rigid a grip can also cause extra fright due to restriction of respiratory exchange.

It must always be remembered that whatever the disease, particularly in small birds, treatment must be instituted immediately, because the course of disease in these species is rapid from inception to death, and may only be 12 hours. It is vital to remember, too, that the first requirement of a sick bird is extra warmth in a temperature of up to 85° F. The writer is very keen on the adoption of infra-red irradiation with low potency lamps now cheaply available on the market. In the subsequent discussion it will be assumed that both these requirements will be met as a prerequisite of treatment.

Feather Biting

This occurs in all species, but is perhaps best known in the parrot. Its cause may be any of the following.

Ectoparasitism.
Dietetic disturbance.
Avitaminosis.
Poor feather growth.
Unclean condition with skin infections.
Depraved appetite.
Boredom.

In the case of ectoparasitism, which will be discussed later, a critical examination of the cage and of the bird will reveal parasites. Their removal may not stop the feather biting, which can rapidly become a habit. Dietetic disturbance is a vague generality meant to indicate that a bird subjected to a sudden change of diet—it may be quality, quantity, or substance—can develop skin hyperaemia like a mammal. The consequent itching may stimulate feather biting. Avitaminosis—again a generality—is quite common in young birds who have received insufficient fresh food in their diet or have been kept in sunless surroundings, possibly associated with winter breeding. Poor feather growth may be a combination of factors, or may be quite spontaneous and perhaps hereditary. It may follow a bad moult. Unclean conditions of housing with or without skin infections cause dirty plumage. The bird may then excessively preen itself and take to feather biting. Depraved appetite

is rare and usually a symptom of senility. Boredom is perhaps the most popular reason for feather biting, but I am puzzled to know why a bird quite suddenly finds its accepted routine of life, housing, feeding and surroundings no longer acceptable, and as an escape for its injured psyche takes to consuming its own plumage.

Diagnosis.

This, of course, is obvious, but sometimes a slow moult will convince the owner that the bird is feather biting when in fact it is not. Bald patches on the head or back are not unusual when the new feathers are coming in. If several birds are together in one cage, one denuded bird may be the victim of one or more companions and not itself be guilty of feather biting.

Treatment.

Remove any parasites by dusting with gamma benzine hexachloride*—both bird and cage. The cage is best scrubbed and, where possible, sterilised. Spray the plumage with warm water in a fine jet to clean the skin and feathers, even in bad cases, actually bathing the bird. Gray suggests that the bird should be sprayed with sulphurated potash lotion, and that occasionally thyroid extract should be given in the drinking water. Evans discusses the disease in budgerigars and states that it concerns only breeding birds when young are in the nest. He says the young have bare areas on the back and head and may be covered with blood. He claims the hen is usually the offender and should be removed, but this may necessitate placing the young with another breeding pair. The injured areas, he suggests, should be treated with metholated ointment in an attempt to stop assault. Diet should be most closely scrutinised, and in the absence of obvious deficiencies, the two golden rules are "change it and cut it down." Gray and others recommend the use—in parrots only, quite obviously—of an aluminium ruffle, mechanically to prevent feather picking. The writer's own feelings are that having established the bird to be vermin-free, clean, well fed and housed, there should be a change of situation, with twigs to chew, or even old cotton reels; and where possible the bird should be kept in the fresh air. A cage companion on some occasions will help. Gray boldly goes further when he says "keeping the bird in a cold room even in winter and with no cover over its cage at night is an inducement for it not to interfere with that which protects the heat of its body from becoming dissipated into the cold air." In some cases of feather biting and inferior moult, the writer has had remarkably good results by injecting B_{12} intramuscularly in the breast muscles daily for seven days.

Vomiting

This occurs quite frequently in the three species but more particularly in the budgerigar. Budgerigars are notably over-sexed and will breed constantly throughout the year unless separated. Feeding the young by vomiting food with "crop milk" secretions is familiar to all, but it seems that the birds will also vomit to each other during courtship. It is not unknown for parrots to behave in this fashion towards the owner. This type of vomiting is of course harmless, but if vomiting occurs in combination with excess thirst associated with depression then it can be more serious. At the same time the bird will probably cease eating.

Diagnosis.

Examination of the crop may reveal crop binding, and the vomiting be an attempt to get rid of coarse material obstructing the crop. Whilst surgical opening of the crop is feasible in the parrot, it may kill the smaller birds. There may be a catarrhal infection of a weak-walled crop, when the organ will be empty and flaccid, and the vomit thick consisting of much mucus. Intestinal infection causing vomiting will be indicated by vent staining, whilst chronic constipation will cause a bloated abdomen and occasional vomiting.

Treatment.

If the vomiting is proved to be associated with illness, the cause should be treated first; *i.e.* if infection of the digestive tract is suspected, antibiotic disinfectants should be administered orally. Oxytracycline* and chloramphenicol† palmitate have proved effective. The former should be administered 1 mg. to ½ c.c., ½ c.c. to be given every four hours. Keymer suggests 50 mg. to 1 drachm of water of which 2 or 3 drops should be administered three times daily, or a dose of approximately 1/10th mg. The writer does not consider this sufficient to produce a rapid gut sterilisation. Variation of diet may be important and induce the bird to recommence feeding.

Enteritis

This heading covers a wide range of disturbances of the normal in the intestinal tract. Some of the causes are:

Chill
Infective agents (Salmonellosis, *B. coli*).
Dietary disturbance.
Fright.
Abdominal tumours.

Frequently one of these causes will trigger off another to become an acute enteritis.

Diagnosis.

In the chilled bird, the history usually reveals a sudden onset combined with some disturbance in ordinary routine (omission to cover the bird at night, a window left open, a windy day with excessive draughts, rapid overnight fall in temperature etc.). The owner may admit to having purchased a different proprietary seed, and close inspection may reveal dirt and other possibly infected material. The writer has known the condition caused by fright from marauding cats, when physical injuries due to fighting are usually observed. The vent may be inflamed by diarrhoeic material, which material will also be seen on the floor of the cage. Abdominal palpation may reveal large tumour masses which interfere with the free flow of intestinal contents. The diarrhoea,

* Gammexane.

* Terramycin.

† Chloromycetin.

which is frequently seen, is sometimes referred to by other authors as a separate entity, but in the writer's experience it is only a symptom.

Treatment.

Consists of the administration of one of the proprietary combinations of, say, sulphaguanidine and streptomycin, mixed equally with chloramphenicol palmitate, five drops every four hours. Even when no infective agent is the direct cause of the condition this is wise, since once an inflammation of the intestinal tract is present, secondary auto-infection is rapid. Extra heat, mentioned earlier, is particularly essential here. The writer is not a devotee of the administration of alcohol as a stimulant since the dosage is so haphazard, and the vasodilation produced may cause cardiac embarrassment. Gray recommends the addition of kaolin to the medicine. Coffin says. " treatment for the various types of disease of the gastro-intestinal tract calls for a rational nutritious diet, withholding of greens or other fibrous material, and supplementation with vitamin A and B complex. Watery or mucoid diarrhoea can sometimes be controlled by administration of small pieces of alopectose pills or by including pectin and kaolin in the diet.

Ectoparasitism

This condition can affect any species of bird. It may play a part in a variety of plumage disturbances and in any case can lead to debility and death.

Mites. Blount gives an excellent summary of a variety of mites affecting birds.

Red mite (of *dermanyssus* sp. most commonly, less commonly of *hiponyssus*) is best known as being a nocturnal invader of cage birds. Not only can these mites cause great irritation and anaemia, but can be vectors of disease, notably spirochaetosis.

Scaly leg mite (*Anemidocoptes mutans*) can affect the legs and/or the beak of, in particular, the budgerigar.

Depluming mites which invade the shafts of the feathers are not very common in cage birds.

Diagnosis.

In the case of red mite, the owner will complain that the bird is depressed and miserable, and usually over preening. Appetite will be capricious and the bird will present a dowdy appearance. Perhaps there may be anaemia and loss of body condition. Scaly face and leg will show encrustation around the cere and the commissures of the mouth, perhaps spreading to the head and neck, or on the legs and feet with disruption of the scales. Removal of some of the debris for microscopical examination will reveal the parasite. Depluming mites cause great irritation with local feather plucking, as well as the exhibition of inferior plumage with half-shafted feathers. A critical examination of the cage and of the perch is most essential in the case of red mite: the parasites may be seen in cracks and crevices, under the perch etc. At the same time they may be seen on the bird, particularly around the vent.

Treatment.

Ruthless disinfection of the cage with 5 per cent. hot soda water followed by steam disinfection where possible. Subsequent light dusting with gammexane powder. The bird should be dusted with DDT powder. Some people believe this to be dangerous to parakeets but the writer agrees with Yealland that this is not so. Yealland advises a 50 per cent. DDT/talcum powder dressing. The writer recommends that this treatment should be carried out every four or five days for two weeks. Scaly face and scaly leg are best treated by removal of the detritus which accumulates, using cotton wool on an orange stick soaked in benzyl benzoate. Daily treatment for 10 days is usually effective, with a subsequent painting with benzyl benzoate of the affected areas in very bad cases. Cage hygiene should be carried out as usual. Depluming mites are controlled by DDT or gammexane, but daily treatment here is required for two weeks at least.

Lice. Not a very common infestation in individual birds, and more commonly associated with large badly run aviaries. Gray quotes lice of the *Mallophaga* species as affecting canaries and budgerigars. Symptoms and treatment are much the same as for red mite.

RESPIRATORY INFECTIONS

Colds. Perhaps one of the commonest causes of enquiry, chiefly affecting the smaller cage birds.

Symptoms and diagnosis.

The bird will be reported as suddenly having gone off its food, sitting miserably on its perch, or at worst huddled on the floor of its cage. Onset is very rapid, the owner asserting that the bird was quite well the day before. There will be occasionally a history of sneezing in an attempt to clear blocked nostrils. When examined the bird shows a discharge from the eyes and nostrils which in the more severe cases will be mucopurulent. There may be a history of a sudden drop in temperature of the bird's surroundings associated with a move to a different room, or an error of management such as forgetting to bring the bird in at night, leaving a window open, etc.

Treatment.

Consists in immediately putting the bird in a high temperature. This is normally sufficient to produce rapid recovery, but in severe cases it may be necessary to administer a medicine consisting of equal parts of oxymel of squills, glycerine, sweet spirit of nitre and ipecacuanha wine; half-teaspoonful of this mixture in two tablespoonfuls of water, the usual drinking water being withheld. The writer has used Crookes "Bromoform," one drop three times daily, with success. If the nostrils become blocked with caseated discharge, this should be removed carefully and the nostrils dressed with a cream. Such caseation can cause permanent distortion of the nostrils and bulging of the infraorbital sinus: in these cases repetitive blocking of the nares even when the bird is recovered will need regular attention. Perhaps it should be mentioned that when administering medicine or applying demulcent creams every effort should be made to avoid soiling plumage. This distresses the bird and leads to excessive preening. Treatment should be immediate, because if left

unattended for 24 hours the simple cold can rapidly develop into a general infection of the trachea and lungs.

Air Passage Infections.

These are very serious always, and may develop from a cold, or spontaneously. The latter is more often the case when several birds are kept and an infection is passed from one to another. There are several main types of infection:—

Coccal.
Mycotic.
Tuberculous.
Psittacottic.
Chronic.

Symptoms, diagnosis and treatment.

In all air passage infections there will be increased respirations with "thumping" of the abdomen, obvious distress, naso-ocular discharges, and not infrequently a gaping beak. Development of pneumonia is very rapid. In the *coccal* forms of infection there is hope of recovery if antibiotic treatment is instituted immediately. The writer injects parakeets with 10,000 units of penicillin intramuscularly twice daily, using the specific penicillin liberated in lung tissue. Extra heat and inhalations are indicated, and where possible it is advisable to increase the oxygen content of the air breathed. This is easily done by leading in an oxygen tube to the covered cage.

Mycotic infection of the respiratory passages is usually first displayed by a gaping respiration, deteriorating into a gasping wheeze with great distress. Positive bacteriological diagnosis can sometimes be made with the aid of a throat swab. Although the disease is uncommon in the lone bird, it may be acquired from infected seed, etc. Treatment can be attempted along general lines plus the use, advocated by Japanese workers Koga, Fukuda, Asakura & Nakagawa, of atomised chlortetracycline.* This, however, is an elaborate and expensive therapy by virtue of the apparatus involved. The writer has failed to achieve any success in the treatment of this disease using oral or injection therapy with antibiotics. It is true to say that when a mycotic patient shows symptoms the disease is usually so well established that there is little hope of recovery.

Tuberculosis of the air passages and lungs in the isolated bird is extremely rare and is only mentioned as a hazard of domesticity. Symptoms of wasting and respiratory distress may be evinced, but quite frequently the condition is only seen at *post-mortem*. The clinician should bear in mind the social problem posed by such a diagnosis.

Psittacosis, when it affects the breathing apparatus, will present symptoms of naso-ocular discharge, usually purulent, with great respiratory distress. Normally there will be concomitant gastro-intestinal symptoms of a greenish, sometimes blood-stained, diarrhoea. More frequently however, a sudden death is found to show psittacotic symptoms at *post-mortem*. These are excellently discussed by Blount. Again, the disease is unlikely to occur in the isolated well-established bird since there is no contact; but since many free birds may have the disease or be carriers outside aviaries may be in danger of infection. Treatment is not desirable, but in any case accurate diagnosis in the live bird is difficult. When there are any suspicions of the existence of the disease in, say, a newly imported parrot showing regular recrudescence of a chronic bloody diarrhoea which is not due to any other isolatable cause, destruction should be advised on safety grounds.

Chronic respiratory infection is perhaps a misnomer since the chronic bronchitis displayed by some cage birds, notably elderly parrots, are in fact likely to be the result of earlier acute infection. The symptom shown is wheezing audible from outside the cage, but otherwise the bird is in fair health. If there is a superimposed chill, then severe respiratory distress will be evinced. This type of case may deteriorate with spasms and seizures, perhaps due to inefficient oxygenation, or in part due to a secondary toxaemia. Treatment is speculative, but Yealland recommends the use of a few drops of camphorated oil on a cage covering cloth at night, leaving sufficient entry for fresh air. The writer is uncertain as to the connexion between bronchitis and so-called asthma of parrots, believing that asthma as it exists in the bird, may well be a respiratory spasm associated with a mild chronic bronchitis. In any case, asthma is usually only seen in older birds. Gray differentiates between bronchitis and asthma, and in the latter case recommends the use of 1 : 1,000 solution of adrenalin, one drop in a teaspoonful of water. It may be that in an old bird a failing circulation may bring about pulmonary congestions which create a respiratory spasm simulating asthma, but the writer still feels that an earlier lung condition may well have been the precursor for this state of affairs. In any case, it is felt that a higher living temperature plus the use of oxygen during an attack may be useful.

ABNORMALITIES

The following abnormalities will be considered in turn.

Overgrown or deformed beak.
Overgrown or deformed claws.
Egg binding.
French moult.
Cage paralysis.
Fractures.
Tumours.

Overgrown Beak.

Quite a common condition of cage birds, due to a variety of causes:—

Senility.
Improper diet.
Debility.
Improper growth.
Infection.
Trauma.

Senility. As the bird—the parrot in particular—becomes senile, it is less able to clamber about its cage using its beak. It is less inclined to sharpen its beak on oyster shell or other hard substance, and certainly ceases to be interested in playthings or

* Aureomycin.

twigs. Appetite may be sporadic with lessening use of the beak.

Improper diet. The inclusion of sloppy foods—bread and milk, cake, etc.—at the expense of hard shelled seed, will predispose to overgrowing of the beak.

Debility. Prolonged illness and lack of appetite will cause the beak to overgrow. The debilitated bird has no enthusiasm for biting activities to wear down its mandibles.

Improper growth in young birds is sometimes seen with the upper mandible exceeding the lower in length. Strange eruptions on the beak may be due to scaly face, which again can cause improper growth.

Infections usually associated with catarrhal conditions may cause a stunting of the upper mandible. The writer has seen one case of suppuration under the cere which caused destruction and perforation of the upper mandible in a parrot. Growth seemed to be checked and the lower mandible had to be kept trimmed back until the condition was cured.

Trauma. Damage to the mandibles from overbiting from any cause can cause excessive wear of one or other of them, causing overgrowth. Fracture of one will produce the same result.

Diagnosis and treatment.

It is essential that the cause of the relative overgrowth be established, and if general treatment is required this should be established first. Trimming the curved upper mandible of the parrot or budgerigar is best carried out with nail clippers, or, in the small bird, with cuticle shears. The upper mandible should always project beyond the lower in these species, but not so much that with the mouth wide open the bird is unable to prehend food or objects. Removal of the excess growth is best carried out on either side of the joint, to leave an artificial point not dissimilar from the natural one. The sides of the mandible may also require trimming back. In the canary, the points of the mandibles should meet exactly, and there should be no gap between the upper and lower lateral edges of the mandibles on the same side. When clipping beaks, only a little at a time should be removed since blood vessels will usually follow the overgrowth down: it is better to clip the minimum to allow the bird to recommence its own wearing activities than to be too ruthless and cause haemorrhage. Once the deformity is rectified, it is of course essential that plenty of hard objects are available for the bird to work upon, and perhaps the best thing of all is a fresh supply of twigs daily for barking. Cuttlefish bone and sugar lumps are also good, and the seed should be examined to see that it is hard and well filled.

Overgrown Claws.

This is chiefly found in budgerigars and canaries. It can be caused by too narrow a perch, or by too small a cage restricting exercise.

Symptoms and treatment.

The bird will be unable to walk evenly, and it will be obvious that the claws are going under the feet. Distortion of toes may follow, with inability to prehend food or objects, notably the wires of the cage. The claws should be rigorously clipped back as near to the blood supply as possible. This latter is readily visible against a strong light. Splinting with nylon of one toe to another helps to correct deformity.

Egg Binding.

The writer has never seen an egg-bound parrot, but has seen several cases in the budgerigar and canary. Gray points out that this condition is better referred to as cramp of the oviduct, claiming that the egg actually has little to do with the condition, since when it occurs the egg is not yet fully formed, not having its shell.

Symptoms and treatment.

Stroud describes an egg-bound bird as a "case of prolonged and ineffective labour." He points out that the bird will be seen to be straining, and may prolapse the vent. If with others it may be the subject of pecking in that area. In all events the condition is likely to be fatal rather quickly, perhaps in 12 hours. Apart from observations of the exhausted condition of the bird and inflammation of the vent, palpation of the abdomen will reveal the egg. The best treatment is to raise the surrounding air temperature to 90° F. or more, and even add infra-red irradiation to that. The bird could be perched on a hot-water-bottle covered with cloth. Lubrication of the vent with oil can be tried, but should be cautious. Some authors recommend holding the bird over a jug of steaming hot water. The writer believes this to be effective, but is nervous of subsequent chill from dampness. Yealland states he has carefully punctured the egg and withdrawn the contents, using a fine hypodermic needle and syringe. Yealland warns of the intricacy of the syringe technique, pointing out that it is important to remember that the functional oviduct of the bird lies on its left side. Gentle abdominal manipulation plus heat usually produces the desired result.

French Moult.

Symptoms and diagnosis.

This disease is seen very infrequently in the Society's collection, and the condition seems to limit itself to certain breeders. It is perhaps seen most frequently in young budgerigars. According to Gray, it is seen "especially among those bred in the seasons with short days and long nights when they are not fed sufficiently often to render them capable of leaving the nest in the shortest possible time after being hatched out. In consequence of this they remain immature and imperfectly covered with feathers, or with feathers that are shed before they have time to reach maturity." Watmough claims the disease to show dropping of the flight and tail feathers in youngsters, with the birds' inability to replace them properly and remaining feathers appearing weak, curly and unnatural. The result of the disease is a youngster unable to fly, known as a "runner." Causation of the disease is not fully understood. Watmough states that in about 1945 Armour Wilson & Campbell carried out some investigations, the results of which were published by The Budgerigar Society (1946). He further says "according to this treatise French moult is attributable to fodder mite." Most authorities, like Yealland, do not subscribe to this thesis, feeling the condition to

be a not well-understood deficiency disease. Yealland further states that in his opinion the birds should not be bred from. Worden recently referred to Taylor's work at Reading which ruled out forage mite, supplying overwhelming evidence that the condition is nutritional. Taylor claims, according to Worden, that French moult birds run short on crop milk secretion, due to lack of production on the part of the hen. As to treatment, some authors agree (Yealland & Watmough, for example) that the feathering becomes normal in the course of time. Yealland's recommendation is that the birds be given plenty of feeding grasses, and their cages be put outdoors at least part of the time with some shelter from direct sunlight.

Cage Paralysis.

This is a vague generalisation for any condition of the functional bony and muscular anatomy of the birds that becomes inactive. The writer has rarely seen it in canaries, occasionally in budgerigars, and quite commonly in parrots. The aetiology of the condition may be divided as follows:—

Senility.
Skeletal deformity or abnormalities.
Atrophic changes in musculature.
Atrophic changes in the feet.

Symptoms and treatment.

The owner will report that the bird is disinclined to move from its perch, and if forced to do so, will be unable to climb or re-perch. The feet may be observed in a claw-like position. One may be able to move the toes about without getting a "grip" reaction. The senile bird may show progressive atrophy of the feet, and even sloughing of toes, although this condition can occur spontaneously or through traumatic injury constantly repeated. It is also known to occur through frost-bite where birds stand on freezing cold floors, although this is highly unlikely in the cage bird. If the bird is young, skeletal deformities should be suspected, and a radiograph obtained. If the paralysis is sudden in onset, a radiograph may demonstrate presence of fracture. Typical cage paralysis can affect both feet and wings and is slow in onset—so much so that quite frequently by the time the owner notices the condition it is too late to attempt treatment. Careful palpation of the thighs and flight muscles—including the pectorals—will indicate if any atrophic changes are occurring in the musculature. Deformities of claws, if permitted to continue, can cause limb atrophy from protracted inability to exercise. Treatment must be based on symptoms. If the bird is young, and radiographic evidence of poor skeletal structure is available, administration of calcium powder on seed with one drop of concentrated halibut liver oil twice weekly should be commenced. Cage size should be increased where necessary and the owner encouraged to allow the bird full access to fresh air. If deformities exist in the toes, their correction may assist recovery, and in this respect it is important to note the diameter of the perch. A perch too big or too small may cause both deformity of the feet and muscular atrophy in the limbs. In the case of atrophic changes in the feet, the writer has had some success with early lesions by immersion of the feet in warm olive oil for 10 minutes three or four times a day, followed by the application of Penotrane.*

Fractures.

Fractures occur most commonly in the budgerigar and canary. Those in the wing are less common than those in the leg.

The wing. The usual site of fracture is in the junction of the middle and lower thirds of the humerus. Not infrequently, and due to the violent flapping of the wing, the fracture is multiple and compound. There will be considerable haemorrhage from the large and powerful extensor and flexor muscle masses which surround the site of fracture.

Treatment. Anaesthesia is essential, since no attempt at repair can be made in a struggling bird. (The writer uses aether vapour for anaesthesia; Keymer states that 1/40th grain pentobarbitone sodium† intraperitoneally is successful). A matchstick applied externally is sometimes effective as a splint, but the feathers should be clipped back to the skin. I think it would be true to say that the repair of high wing fractures depends on the amount of tissue damage and the inspiration of the clinician. Many claim that the bird is best left alone to heal spontaneously. At best the bird will be left with a wing drop on the injured side. Lower wing fractures, *i.e.* of radius and ulna, phalanges or digits, are progressively less complicated. The writer has several times with success amputated the wing at the site of fracture in birds up to the size of a pigeon. Welland reports the successful amputation of the lower wing of a hawk.

Leg fractures, Most common, again, in the budgerigar or canary. Fractures of the humerus are best left to heal spontaneously, accepting the fact that a certain amount of shortening of the leg will be inevitable. Perhaps the commonest site of fracture is the tibio tarsal joint. Actual fracture, either of the lower end of the tibia or upper end of the tarsal bone may be complicated with luxation of the tarsus joint. If the fractures are compound—as frequently they are—amputation of the limb below is perhaps best. Clean healing is unlikely without this, and subsequently the dangling limb will only be a hindrance to the bird. Amputation can usually be achieved without anaesthesia, since by now trauma will have anaesthetised the area, and haemorrhage will be the only matter of moment. Lower leg fractures are less common, and again are nearly always compound. They can readily be repaired using external fixation under anaesthesia (Ratisand). A variety of splints will spring to mind, but perhaps the most popular is a feather quill splint longitudinally and bound in position over a little wool. Careful wound dressing first is essential; the writer has seen cases of gangrene develop very rapidly from infected compound fractures. The splinting procedures are best carried out under light anaesthesia. Once applied the splint should remain in position for three weeks, while the bird is confined to a small cage with a low perch.

† Banocide.
† Nembutal.

Tumours.

The existence of neoplasms in cage birds is well recognised. Fox (1933) has listed a wide variety in his analysis of *post-mortem* findings at the Philadelphia Zoological Gardens. Gray (1936) also notes their " not infrequent " occurrence, observing that they may be malignant or simple, such as lipoma. Goffin (1953) says that the budgerigar appears particularly susceptible to them. Malignant tumour formation is, of course, inoperable, and in any case is rarely diagnosed *ante-mortem* either due to siting or due to the fact that illness from such tumours is rare, giving no indication of their existence up to death. The simple lipomata, however, are frequently diagnosed. Internally they may take the form of freely mobile and easily palpable swellings in the lower abdomen. Their existence does not always worry the bird unless there is interference with bowel activity from pressure, or with exercise from weight. Such patients are best destroyed. Cutaneous and subcutaneous lipomata occur, sometimes pendulous in the case of the ageing parrot, which can be dissected out under general or local anaesthesia. This should only be advised where mobililty or function is being interfered with, and when perhaps from friction, ulceration is occurring.

MAMMALS

To-day a wide variety of unusual mammals is kept by the pet-owning public. These include mongooses, monkeys, rats, mice, rabbits, squirrels etc. Perhaps the commonest trio would be monkeys, hamsters and guinea-pigs.

Monkeys

Monkeys are primates, and being quite closely related to man have many features which are quite similar. Thus their physical and anatomical make-up is alike to that of man, with not dissimilar dentition, hands and feet with nails, not claws, frequently a bi-pedal stance etc. Not least among the similarities, however, is the ability of some primates to contract human diseases, and to pass on their infections to humans. Mostly this will apply to the higher primates, viz. the anthropoid apes exemplified by the gibbon, chimpanzee, gorilla, and orang utan. With the exception of zoological collections, the monkeys the practitioner will more frequently be called upon to attend can be listed as follows:—

Old World Monkeys:	The African Green,
	The Rhesus,
	The Chimpanzee.
New World Monkeys:	Marmoset,
	Humboldt's Woolly,
	Spider Monkey.

Old World Monkeys.

The African Green Monkey (or grass monkey) is a large monkey about 12 to 14 inches body length with a tail about as long. The face and hands are black, the hair on the back being green-grey or variants, with a light-coloured chest and abdomen. It is fully adult at three to four years of age, but may not breed until five or six. Details of the sexual cycle are fully described by Asdell (1946) in " Patterns of Mammalian Reproduction." The rhesus monkey (or "soldier monkey") comes from India and is smaller than the grass monkey. A fully grown male may be 10 to 12 inches in body length, but the average size is less. The tail is about half the body length, the colour fawn and the skin light. The females show red coloration of their thighs and buttocks when they become sexually mature at the age of three years or so. The chimpanzee is familiar to all; it comes from areas of West Africa. Young ones will vary from 10 to 12 inches long at one year or so to 2 feet 6 inches at five years of age. The animals are tailless, and beyond six years old invariably dangerous except to their owners.

New World Monkeys.

These are typified in popular choice by the marmoset, a small creature from areas along the Amazon. Body length is about 6 inches or less, with an equally long bushy tail. They have claws not nails as we know them. Pronounced ear tufts of various colours are seen; in the common marmoset these are white. The Humboldt's woolly monkey is a very popular but expensive animal. It may be chocolate-coloured or grey to golden, but its skin is usually dark. Its hair is close and fine, and its head is closely cropped, looking like a "black sambo." In size it is much like a grass monkey, but the most important feature is the prehensile and very long tail. As a grip, the terminal 2 or 3 inches of the tail on the anterior surface are hairless, and of the texture of the palm of the hand. The spider monkey is usually black coloured, with long hair and large eyes. The arms and legs seem disproportionately long and again the tail is prehensile. It is not proposed to discuss diet in detail since this does not come within the scope of this paper. It should be remembered, however, that all monkeys are vegetarians, but with a leaning to omnivorous taste. They will take, and require a certain amount of protein, found in the wild as insects, birds' eggs, fledgelings, small rodents etc. In captivity these requirements can be met by feeding milk, eggs, mealworms, gentles, or shreads of raw meat. The specialised leaf-eating monkeys, such as colobus, are rarely met in captivity as domestic pets.

DISEASES

No attempt can be made to cover all the diseases from which primates suffer. It would be invidious to burden the clinician with details of tropical medicine readily available in standard text-books. But the clinician should always remember that the monkey he is called to attend may well be suffering from a disease he has brought in with him from abroad, or has acquired since his arrival, or both. At all times the attending veterinary surgeon should remember that many infections of primates are transmissible to man, and *vice versa*. Scrupulous hygiene on the part of the owner, both personally and with regard to his pet, should be insisted upon. For these reasons the writer is against owners cuddling monkeys. Further consideration of the problem will be divided as follows:—

Restraint and anaesthesia.
Routine for examination.
Common diseases.

Restraint and anaesthesia.

These two procedures are put together because the latter will often follow the former, and its achievement is frequently impossible without it. Some monkeys will allow strangers to handle and examine them minutely with or without the owner holding them, but this is unusual. If, however, the owner is unwilling or unable properly to restrain the patient then a variety of techniques can be adopted. In the small monkey the use of a glove and grabbing the animal by the scruff of the neck usually works. It sometimes pays to throw a duster over the creature first of all, so that it cannot observe the hand approaching. In the larger animal with a long tail, if the tail is caught and the animal pulled towards the cage door, the tendency will be for him to pull away from the hand in an effort to escape. While he is doing this the free (left) hand can travel up the monkey's back to grip the neck at the base of the skull. The grip on the tail can now be relinquished and transferred, if necessary, to the legs, which are stretched downwards. In a very violent monkey the owner, or an assistant, can safely restrain the animal by holding both arms behind its back and both legs pulled downwards. If the animal is too fierce an adult to permit these methods of restraint, it is perhaps best to employ nets. Bag nets suspended from a steel ring are simply constructed and most useful.

In the writer's opinion much the best way to examine such an animal is to anaesthetise it. A useful anaesthetic box suitable for the purpose can also be used for cats and dogs for minor interferences. A gas section leads off a catching cage, and the animal is driven into it by lowering a flap. The end of the chamber has a perspex slide to allow observation, and the gas of choice for rapid and short interferences is N_2O. Further anaesthesia can readily be achieved by the intraperitoneal injection of pentobarbitone sodium 1/6th gr. per pound bodyweight. Some workers prefer to attempt intravenous anaesthesia using the vein tranversing the orbital fossa of the forearm, or the saphena vein over the ankle. The writer has found intraperitoneal anaesthesia eminently satisfactory and much simpler.

Routine for examination.

Examination of the unrestrained patient will give a clear impression of the state of health. Quickness of mental reactions, aggression, physical activity, glossy pelage, clear eye and a clean cage should be noted. Diarrhoeic material should be observed for colour, consistency, and presence or absence of blood. When the animal is restrained, a critical examination of the mucous membranes should be carried out. Auscultation of the chest and back will reveal lung conditions. Temperature and pulse are rarely any indication in the restrained animal, but perhaps it should be noted that most monkeys have a normal temperature of about 98°5 to 99°5 F. A blood smear should always be obtained by pricking the ear—this is most essential to get an idea firstly of the state of the blood itself, but also as an aid to detecting blood parasites both *intra* and *extra* corpuscular. Faecal material is always readily available at this stage for collection and examination.

With regard to general restraint measures Dall suggests, most ingeniously, that a wickerwork waste-paper basket can be inverted over a monkey, which will allow the operator to take hold of the animal's tail without danger.

Common diseases.

It is assumed that the practitioner will always go through a routine examination as described, to include laboratory examination of blood, urine, faeces and sputum where available. By this means clinical diagnosis will be simplified and treatment made more specific. The commonest diseases he is likely to be confronted with are as follows:—

Tuberculosis.
Diarrhoea and dysentery.
Chest infections.
Casualties and surgical cases.
Deficiencies.
" Fits."

Tuberculosis.

The incidence of this disease in the pet monkey is unknown; there has been much written about the disease as it appertains to the experimental animal. Kennard & Willner (1940-41) generalise that in a study of 2,000 rhesus monkeys over 10 years, the incidence of tuberculosis is 25 per cent. at one stage or another. Recognition of the disease in the monkey occurred before the bacillus was identified, when Koch in 1884 described tuberculosis in monkeys, commenting on its rapid course and wide distribution of lesions in the body. Since this time a host of workers have investigated the various aspects of the infection as it applied to the monkey. Thus MacFadyean claimed that the disease develops 10 days after infection, followed by a fulminating spread throughout the body to death in two months. The type of bacillus can be human, avian or bovine, but without doubt the human strain is the commonest and most lethal. Authors vary in their opinions as to where the primary lesion will occur. Rabinowitsh in 45 infected monkeys, found primary lesions in the lungs in five cases, in the abdominal cavity in nine, in both sites in the remainder. Fox claims the primary lesion to be in the gastro-intestinal tract, Nieberle in the lungs. It would be far too time-consuming to examine all the literature available on the subject—the main thing to remember is that a monkey can easily introduce the disease into a household; in any case a pet monkey with the disease can pose a delicate domestic problem in that the owners may resent the suggestion that they themselves may have the disease.

Diagnosis.

The usual classical symptoms of loss of bodyweight, chronic cough and progressive weakness may be present. Throat swabs should be examined and where possible X-ray examinations carried out. A diagnostic test should be applied, bearing in mind that some tests show no reaction in an animal in the advanced stages of the disease. Originally, old tuberculin was injected subcutaneously, with hourly temperature recording for 48 hours; the writer believes this to be inaccurate and cumbersome. Modern methods revolve around the injection of 0.1 c.c. of

tuberculin intradermally in the skin of the eyelid or the abdomen. Local hyperaemia and oedema in 72 hours indicates a positive reaction in an infected monkey. Experience suggests that 0.1 c.c. of B.C.G. vaccine intradermally in the skin of the upper arm is more accurate, in that whilst tuberculin may fail to pick out an advanced case, B.C.G. used as a diagnostic test will show a Koch's phenomenon in the same case. This, at the moment, is only opinion and not established fact, since it is as yet based on three years' observation covering something over 100 cases.

Treatment.

The clinician may very justifiably decide to advise the owner to destroy the animal on grounds of safety. If, say, in the case of a valuable performing chimpanzee, it is desirable and safe to attempt treatment, it is of significance to note that experience in the Zoological Society of London has shown that adequate dosage of I.N.H. (15 mg. per lb. bodyweight) with P.A.S. (two drams per 14 lb. bodyweight) plus a modified diet to contain milk protein *ad lib* with adequate B group vitamins, will frequently produce a clinical cure. In addition, where possible, streptomycin should be administered daily on a bodyweight basis.

Prevention.

On this subject much remains to be learnt. In the writer's experience, vaccination with B.C.G. is wise; a special vaccine of 40 mg. per c.c. strength is used in 1 c.c. doses subcutaneously. This produces a local cold abscess which may take 6 to 12 weeks to disappear. Check testing is recommended at six-monthly intervals, and where a negative result is obtained, then re-vaccination should be advised. This technique follows the usual practice in humans where, in the absence of a primary lesion, indicated by a negative Mantoux test, vaccination with B.C.G. is instituted. Resistance to the disease is indicated some weeks later by a positive Mantoux—a process known as "conversion." Thus, conversion in the monkey is checked six weeks after vaccination and six-monthly thereafter.

Diarrhoea and Dysentery.

The monkey is a constant feeder in the wild. Equally he will defaecate freely at any time. The consistency of the motions of the lower orders of primate is semi-solid. Only in the apes does it begin to take on a formed shape. Usually, when handled, the monkey patient will defaecate freely from fright, and possibly urinate too. Whilst this makes the problem of sample collection simple, it may deceive one into thinking that diarrhoea is present. The two conditions have been linked together because, very frequently, a true diarrhoea in a monkey will follow on to dysentery by the very nature of the infection present.

Ordinary diarrhoea.

In the monkey, this can be caused by too frequent feeding of a much-varied diet. In captivity one feels that daily feeding is sufficient; this will supply all the nutriment required by a caged animal, and will limit the amount of defaecation. As previously mentioned, a mixed diet of fruits, vegetables, and traces of meat of one sort or another, is sufficient. Frequently, however, one finds the animal being fed during the day on a wide variety of material including cakes, buns, bread and butter, chocolates, tea and even spirits. Apart from the intrinsic ability of this diet to cause sporadic diarrhoea, there is the risk that half-consumed fragments of food will lie on the floor of the cage to become sour and contaminated, and when eaten later in the day or during the night, will cause auto-infection. Clearly, then, strict diet should be adhered to.

Treatment.

Treatment consists of the withholding of food for 24 hours, giving boiled milk or arrowroot to drink and, in severe cases, the administration of a demulcent such as kaolin. By this time a faecal examination will have been instituted and any serious infection detected. As is the case in other diseases, a lowered bowel resistance from any cause can create circumstances where normal bowel commensals—of which there are many in the primate—can become pathogens.

In the case of diarrhoea and dysentery the main causes of the condition are as follows:—

1. *Bacterial*—any or all of *B. coli*, *B. shigae* (*Shigella dysenteriae*), *B. flexueri* (*Shigella paradysenteriae*), *B. typhosum* (*Salmonella typhi*).
2. *Protozoal*—Amoebae (*Entamoeba histolytica*), Giardia, Balantidium—*Balantidium coli*, Coccidiosis.

(Gaiger & Davies classification).

Symptoms.

The symptoms of these infective dysenteries are similar. Onset is rapid and often fatal in 24 hours. Dehydration is most marked with severe depression. There may be acute abdominal pain. Fluid may run freely and uncontrollably from the rectum, and in advanced cases haemorrhage is pronounced.

Diagnosis.

This is largely by the clinical symptoms backed by immediate laboratory examination for precise identification of the causal organism.

Treatment.

Extra heat immediately is essential. If abdominal pain is great, deep narcosis with intraperitoneal barbitone sodium is useful. Subcutaneous injection of plasma restorer assists in counteracting dehydration. The specific drug to be used will depend upon the laboratory diagnosis, but useful ones will be Carbasone (B.W.G.), oxytetracycline*, oral, or a synthetic quinine. Drinking fluids should be replaced with a liquid bowel disinfectant such as a proprietary mixture of sulphaguanidine and streptomycin. Oral administration of drugs presents a problem from patient resistance with exhaustion; the use of a steel pipette or long dressing forceps for pills largely overcomes this.

* Terramycin.

Chest Infections.

Tuberculosis having been mentioned earlier, no further discussion of this disease as it affects the chest will be entered into.

Chest infections in monkeys really divide themselves into *primary* and *secondary*. Secondary infections will occur concurrently with other general infections either from a bacteraemia or from debility and posture producing a chest hypostasia. They will be guarded against in the treatment of the general condition.

Primary infections of the chest have a wide range of aetiology. The higher apes are susceptible to human infection both bacterial and viral, so that streptococcal, pneumococcal, influenzal, and common cold infections may be expected. The commoner monkeys are susceptible to sudden temperature changes and draughts—particularly soon after arrival in this country—and can develop upper respiratory infections which quickly descend to the lungs and bronchi.

Symptoms and diagnosis.

Elevated temperature to 103° F., malaise, naso-ocular discharges, anorexia, coughing, with respiratory râles upon auscultation. Swabs should be taken on all occasions.

Treatment.

This is very much a question of nursing, together with a draught-free, warm enclosure (75° F. minimum) during the course of fever. Administration of 100,000 units of penicillin ester* twice daily by intramuscular injection in the thigh muscles is indicated. The face should be kept free of discharges, and if the animal readily permits it, soothing drops should be instilled in the nose to prevent catarrhal coagulation. Much relief is afforded by inhalations such as friars balsam. If the appetite remains capricious, no attempt at feeding should be made for 48 hours, but a plentiful supply of milk and glucose should be available. As the condition improves, the temperature can be lowered progressively to room temperature. Antibiotics should be injected for at least five days, since even when recovery seems dramatic, monkeys are very weak-chested and liable to rapid relapse. After the illness, and during convalescence, a high protein diet should be fed thrice daily in very small amounts. If a chest wheeze persists, "Bromoform," half a teaspoonful four times daily, is most efficacious.

Casualties and Surgical Cases.

These may be classified as follows:—

Injuries and fractures.
Castration.
Removal of canines.
Abdominal surgery.

Injuries.

If more than one animal is kept, fighting can produce the most savage wounds: the monkey can use hands, teeth and feet simultaneously. Ordinary minor surgical procedures, with which all are familiar, can similarly produce healing in the monkey. The problem of the maintenance of cleanliness of the wound, however, is more difficult. The patient will be inquisitive of sutures, and it is necessary to paint the wound repeatedly with a topical anaesthetic while healing is occurring. Most people will also administer a strong sedative such as syrup of nembutal (1 gr. to 1 dram) by mouth, one teaspoonful four times daily, for the first 48 hours. Superficial dressings are contra-indicated since they only tend to draw the animal's attention more forcibly to the wound.

Fractures.

These are uncommon except in the very small animals, or those with a deficient skeletal system. The use of external splints is possible, but the writer has seen one patient with a fractured radius and ulna repeatedly and rapidly remove its cast, even although the final cast consisted of plaster of Paris bandage covered with sheet tin which itself was bound with soldered copper wire. Clearly there is an indication here for internal fixation to be practised. In severe infected compound fractures, amputation of the affected member is best in the domestic pet. The monkey will be little embarrassed, by reason of its ability to use feet and hands. Those animals suffering from fractures of the shaft bones, spine or pelvis attributable to gross osseous deficiencies are best destroyed.

Castration.

The clinician may often be approached by the owner of a monkey rapidly approaching sexual maturity. At this stage the canine teeth of upper and lower jaw are becoming savage weapons and the animal will be demonstrating aggressiveness to strangers, and indeed to all except one person. The advice here is that castration of the animal, male or female, may somewhat modify its temperament. Removal of both testicles under general anaesthesia is carried out in much the same fashion as for the dog, but fear of infection is greater due to the animal's incomparably dirtier habits. Post-operative care must be the greater, with the measures already detailed under Injuries. In the female ovarohysterectomy can be performed by a midline incision, remembering the animal has a unicornuate uterus.

Removal of Canines.

This procedure will not, of course, modify the animal's behaviour, but will minimise the amount of damage which it can inflict. The roots of the canines extend vastly into the rami of the jaws, and removal of the teeth must be carried out with great caution under general anaesthesia. The use of dental elevators is most essential, and it is usually advisable to cut the gum also. The writer does not believe in cutting the teeth back; in fact, generally speaking, if the animal's behaviour is such that there seems a need to remove its teeth, it would be better to dispose of it.

Abdominal Surgery.

Rarely called for, but the clinician should remember that the higher apes are possessed of an appendix vermiformis. The Zoological Society of London has recorded several cases of sudden death in gibbons from septic peritonitis due to a perforated appendix. Caesarean section, or complete hysterectomy occasionally, is required and only becomes difficult in the very small breeds such as marmosets, where the surgical shock is great.

* Estopen.

Deficiencies.

The classical symptoms of lack of any of the known vitamins and minerals, ranging from skin lesions, central nervous symptoms, infertility, through to bone deformity are known to us all. Two conditions, however, are often met by the clinician:—

Cage cramp or cage paralysis, and hind leg paralysis of marmosets.

Cage cramp may well be accelerated by bad housing where it is obvious that there is insufficient exercising room. At the same time, in the writer's experience, the lack of the B group from diet can produce a progressive inability to exercise. The animal will prefer sitting on its perch or on the ground, and will progress about its cage by the use of its hands and arms, even holding its legs up and swinging its lumbar region between its arms like a pendulum whilst balancing on its hands.

Treatment—occupational exercise with ropes, swings, slanting ladders, etc., in combination with raw liver or liver extract, plus a course of B_{12} injections for 10 days. Recovery will be very slow. Removal of the perch and placing food on a higher tray encourages the use of the legs. Vitamin E should be administered also at the dosage rate for a Poodle.

Hind leg paralysis of marmosets. This is given a special place since it is the most frequent cause of the owner coming to the veterinary surgeon. Aetiology must derive from the fact that frequently the animals are shipped home from South America in large batches as youngsters in ill-lit and ill-ventilated surroundings. One surmises, perhaps with some justification, that in its natural surroundings the marmoset has a high intake of luscious vegetation and a very ample irradiation with sunlight. Almost more than any other species the marmoset shows skeletal deficiencies which must be due to a calcium/vitamin D deficiency of its new habitat.

Symptoms and treatment. The owner will complain that the animal is unable to use its perch, drags its legs, or, at worst, holds its thighs up to its abdomen. There is great pain if any attempt at straightening the legs is made. Radiography will show multiple lesions which may include osteoporosis of the femurs, osteoarthritis of the hip joints, luxation of the articular head of the femurs, and collapse of the pelvic anatomy. These cases are hopeless. Early cases respond to irradiation with infra-red and ultra-violet. There is a new low potency 24 hours ultra-violet lamp* which seems most efficient. Calciterol† should be given, one drop daily, with calcium lactate. Plentiful twigs for exercise will assist recovery. Whilst in the young animal correction of the deficiencies is possible. a return to normal functional activity is most doubtful.

"Fits"

This is a loose term applied to violent spastic spasms of the voluntary musculature, which in turn can be accompanied by lack of control of involuntary muscle, with urination and defaecation. The lips may be drawn back in a "death's head" smile and the jaws locked or chattering. The fit may be short or long in duration, but is always followed by a period of exhaustion and mental apathy. In the monkey the main causes of the condition seem to be:—

Senility, circulatory failure with cerebral anaemia, diabetes, renal failure, helminthiasis, or female cyclical disturbances.

Diagnosis and treatment.

It is felt that in most cases of repetitive fits, narcosis may assist if only because it may prevent excessive physical fatigue, and because it will give the clinician time to examine natural excreta. In this manner sugar in the urine may indicate diabetes, although Hill has noted that most monkeys, on death, have sugar in the bladder contents. Heavy helminthiasis may produce toxaemias, whilst careful auscultation of the relaxed heart may reveal valvular deficiencies. Renal failure may present a classical urine analysis but also oedematous swellings of hands and feet. Some owners are concerned about rabies. It is true that monkeys can contract rabies (Lamb & Mackendrick, 1909) but their ability to act as carriers after importation seems in doubt. It should be remembered that, of all susceptible animals, the monkey would seem the least likely to be in contact with infection, due to its agility. The treatment of "fits" must be symptomatic.

HAMSTERS AND GUINEA-PIGS

Whilst, in the eyes of the professional breeder, the joint classification of these two members of the order *Rodentia* would be regarded as pure heresy, there are many similarities of management and of disease, which, in the writer's opinion, justify such classification from the veterinary surgeon's point of view. A brief description of the features of both animals is appended.

The Guinea-pig (*Cavia porcellus*)

These little animals are natives of South America, and apparently the Indians of Peru used to domesticate them and keep them for food. According to Cumberland (1905) the term "pig" was applied to the animal in early times because in Peruvian markets the animals were offered for sale as food ready prepared for the table. They had the appearance of sucking pigs since they had had their hair scalded off as an ordinary pig does. The appellation "Guinea" was apparently due to early navigators who spoke of Guinea as part of the Indies where the animal was seen. Topsell (1607) refers to the guinea-pig as the "Indian little pig coney."

There are many varieties of guinea-pig to-day, and fanciers tend to classify them by the length and direction of the hair. The English varieties are smooth, short-haired animals, in a variety of colours including tri-colours. The Abyssinian variety has short, rough hair, radiating out from centres known as rosettes. The third variety is the Peruvian, which has long hair frequently shaggy looking, and extending over the head and eyes. So far as breeding is concerned, Hughes (1947) states, "the sexes may be mixed in the proportion of one male to five females. The gestation period is between 66 and 72 days. The litter may be left with the mother for 12 to 14 days, or, alternatively, each young guinea-pig may be removed from its mother when it reaches the weight

* Philips.
† Radiostoleum.

of 170 g. The female, or sow, may be placed with a male between a week and a fortnight after her litter has been weaned. A sow has a useful breeding life of up to two years and is first used at about four to six months of age. A sow can breed three litters per year, with an average of 3.5 animals per litter." With regard to diet and housing, the writer prefers that the animals should be pellet fed, receive their water from water bottles operating on the vacuum principle, and be housed in wire-floored cages. To some owners, however, this smacks too much of the laboratory. All authors are agreed that guinea-pigs demand a large quantity of vitamin C (ascorbic acid) fed as greenstuffs such as cabbages, lettuces, carrot tops, etc. Roughage is supplied as meadow hay, plus grain. On the latter food, Ibsen (1950) quotes a laboratory mixture as follows:—"To every 100 lb. of ground oats are added (and thoroughly mixed in) 11 lb. of mixture containing the following:—

Bone meal, 1.5; skimmed-milk powder, 2.0; soya-bean meal, 2.0; meat tankage, 2.0; wheat shorts, 2.0; cotton-wead meal, 2.0.

Hughes (1947) speaks of a mixture of bran and dried sugar beet pulp 2 : 1 fed in the morning at the rate of 1 oz. per animal. Crushed oats can be used as an alternative to sugar beet pulp. In the afternoon, hay and greenfood are provided. Hughes specifies meadow hay as coarser varieties might cause injuries to the mouth, nose and eyes. He further quotes a personal communication from Patterson (1944) that at the Institute of Animal Pathology, Cambridge, the following rotation of green foods is fed there:—

January—April, thousand head kale and mangolds;
May—June, fresh grass, spring cabbage or chicory;
July—October, chicory, savoy, cabbage, marrow stem kale;
November—December, marrow stem kale and mangolds.

Diet has been discussed at some length because the writer is convinced that well-fed guinea-pigs rarely become ill, it is ill-conceived and irregular feeding which precipitates disease. Even Cumberland (1905) says, over incorrect diet, "I found as Autumn came on, that the cavies became weakly and developed fever and inflammation of the lung." The pet owner would do well to maintain a very strict routine of feeding with crushed oats and bran in the mornings, and hay and greenstuffs in the afternoon. Bedding may be made from a variety of materials, but newspaper seems ideal being cheap and easily taken out two or three times weekly and burned. All stale food should be removed daily.

The Golden Hamster (*Mesocricetus auratus*)

This variety of hamster is the popular one so familiar as a domestic pet. It is interesting to note that all the many thousands of hamsters in this country are descendants of two pairs presented to Dr. Edward Hindle by Dr. S. Adler in 1931. Until quite recent years only two examples were known, one a female from Aleppo, described by Waterhouse, April 9th, 1839, at a meeting of the Zoological Society of London, and a second one preserved in a museum in Beirut. The originators of the two pairs presented to Dr. Hindle were dug up in a burrow outside Aleppo by I. Aharoni of the Department of Zoology, Hebrew University, in 1930. In her eminently useful handbook *Hamster Guidance* (1949), Mrs. Jean Cook says: "the Golden Hamster is a small rodent measuring about six to seven inches long in a good specimen when fully adult. In appearance it rather resembles a miniature bear while combining the hoarding habits of the squirrel and the acrobatics of the monkey." Further, she says: "on each side of the face the hamster carries a cheek pouch with unbelievably elastic powers, and quite unconnected with the digestive organs. The amount that can be stowed away in these must be seen to be believed. Nothing coming amiss from a puppy biscuit to a postage stamp."

In the wild the animal lives in deep burrows and uses its cheek pouches to take food back for hoarding, mostly grain. The gestation period for the hamster is 16 to 18 days, litter size 2 to 15, the young leaving the nest at 18 to 21 days old. Like the guinea-pig, the average expectation of life is around two to three years. Hindle says a metal box is preferable for housing the creatures, since they are liable to gnaw through a wooden one. The writer subscribes to removable floor-covering, such as newspaper, but others prefer sawdust, peat moss, hay, sand, etc. The diet of the experimental hamster has received considerable attention, and it is interesting to note that unlike the guinea-pig, it does not require ascorbic acid (Clausen & Clark, 1943) but nicotinic acid is essential (Prouth & Houchin, 1942). Full details of investigations are available on reference to Hindle's chapter on the animal in the UFAW handbook 1934. In this book, for routine feeding Bruce and Hindle suggest a daily feed of puppy biscuits, monkey nuts, and mixed grain (wheat, oats, barley, etc.) to which are added 2 or 3 g. per head daily of raw carrot, greenstuff, or sprouting tares. This diet with fresh cow's milk to drink, is adequate. Cook quotes a list of suitable foods as including cheese rinds, fried bacon rinds, fish skin, porridge, raw cabbage and carrot, lettuce, spinach, chickweed, etc. She goes on to add that a mash of cat food moistened with milk or gravy is desirable.

DISEASES

Since both guinea-pigs and hamsters are established laboratory animals, their diseases have received some attention. The hamster, as a later arrival, is still a somewhat unknown quantity in some respects, and in any case laboratory workers are seldom interested in treatment of disease when eradication is preferable. As in the case of birds, the owner of the individual animal is unlikely to experience epidemic infections such as those in laboratories. At the same time, the individual animal runs the same risks of contact with human infections, infected bedding and food, and temperature or humidity variations. As has been emphasised in other sections of this paper, prevention of disease by scrupulous hygiene and proper housing, combined with judicious feeding, is far simpler than attempting to cure the result of non-attention to these details. In the writer's experience the clinical symptoms of the majority of diseases affecting the guinea-pig appear much the same in the hamster, and at the

risk of severe criticism, these will all be discussed together except where specifically excepted as applying to one animal or the other. General bacterial infections appear to be very similar, but viral infections may differ, where known at all. It is proposed to mention some diseases as follows, based on that excellent analysis by Parish (1950):—

Bacterial Infections

1. Respiratory infections. 3. Salmonellosis.
2. Streptococcal infections. 4. Pseudotuberculosis.
5. Miscellaneous infections.

Ectoparasitism

Wounds

Bacteriological Infections

Respiratory Infections

Both guinea-pigs and hamsters are subject to these, but guinea-pigs are the more so.

Symptoms and diagnosis

Frequently, death is the first indication of illness, when *post-mortem* will reveal pneumonia and pleurisy. There may also be petechial haemorrhages and generalised septicaemia. A variety of organisms may be involved, commonly a pneumococcus, less commonly a pneumobacillus, streptococcus, a member of the pasteurella group, or *Haemophilus* bronchisepticus. In the less acute case there will be "thumps" with or without oculo-nasal discharges. Occasionally some animals sneeze and discharge muco-pus. Complete lethargy and anorexia, ruffled coat and a huddled appearance are common. In the hamster no attempt at storing food will be made and the cheek pouches will remain empty. A careful check of accommodation should be made, since wide ranges of temperature are dangerous, particularly if the owner is given to removing the animal from its sleeping quarters to play with it. Hamsters, in particular, enjoy periods of aestivation when outer air temperature drops much below 35° F. This trait is known better, perhaps, in the wild state as semi-hibernation, and is mentioned by Poiley (1950).

Treatment.

Immediate raising of surrounding temperature to 70° or 75° F. with the use, also, of low potency infra-red irradiation. A broad spectrum antibiotic should be used at puppy dosage, because there will be insufficient time to permit laboratory diagnosis of the causal organism. The writer also uses steam inhalation boxes incorporating friars balsam or similar product. In the toxic anoxaemic case oxygen should be administered.

Streptococcal Infections.

A wide variety of streptococci is known to cause disease in guinea-pigs but the writer has experienced very few in hamsters. Mostly the infections are due to the haemolytic streptococcas. There are two well-known conditions of the guinea-pig, the first of which has been known in the writer's experience to affect hamsters. They are septicaemia and cervical adenitis.

Symptoms and diagnosis

In the *septicaemic* type there will be no symptoms during life. The course of the disease is so rapid that the writer has actually seen guinea-pigs die whilst watching them as a group. They suddenly become lethargic, totter a few steps and fall on their sides. Quite obviously this is an end point to an infection which has a rapid course and shows no malaise.

Cervical adenitis is described by many workers quoted in the UFAW handbook. The cervical lymphatic glands become very enlarged and sometimes burst, discharging thick pus.

Treatment.

There is no treatment for the acute septicaemic infection, but simple lancing of abscesses will nearly always produce a cure of cervical adenitis. It is as well to warn the owner that the infection may have been introduced on coarse hay. Naturally, if the patient comes from a collection preventive measures should be taken to stop the spread of infection.

Salmonellosis.

The writer is familiar with this disease in both guinea-pigs and hamsters. There are two types, the chronic and the acute.

Symptoms and diagnosis

In the chronic form general malaise for several weeks will cause progressive emaciation. Infrequently there is diarrhoea, but the animal always looks poor and wretched. A *salmonella* organism can usually be isolated from faeces (*S. typhi-murium*, *S. enteritidis*, or others). Sometimes, in a group of animals, a carrier is only detected by faecal examinations after the death of one animal. In the acute form death occurs in 48 hours, usually with diarrhoea, but giving little in *post-mortem* appearance. The *post-mortem* findings of the chronic case are listed by Parish (1950) as being pus in the gall bladder, congested and/or ulcerated intestines, enlarged and oedematous lymph glands, spleen and liver enlarged and often studded with greyish areas or abscesses, general or local peritonitis, and occasionally abscesses in the uterus.

Treatment

The writer has had some considerable success using nitrofurazolidones as for poultry. In fact, a sick hamster or guinea-pig, when admitted to hospital, is always put on a diet which contains sulphaguanidine, streptomycin, and nitrofurazolidone. Such treatment is commenced after a high rectal swab has been taken, and whilst it may seem empirical is deemed advisable in view of the speed at which the animals can die. Prevention of the disease is assisted by careful feeding. A lowering of gut tone from dietary causes may cause a latent infection to flare. Rat-infected faeces are perhaps one of the most constant causes of salmonellosis.

Pseudotuberculosis

This is a disease of the guinea-pig well known to laboratory workers but rare in the individual animal. It is caused by *Pasteurella pseudotuberculosis* in the main, but certain other organisms can cause a pseudotuberculosis pathological process.

Symptoms and diagnosis

There seem to be three main types of the disease: an acute form with rapid death from septicaemia showing little upon *post mortem;* a chronic three- to four-week variety with vast enlargement of the mesenteric lymph glands accompanied by emaciation,

weakness, and finally death; and a glandular form involving the cervical region.

Treatment

The writer has no experience of the treatment of the disease and has no suggestions to offer. Perhaps there is an indication for modern chemotherapy, or for the use of antibiotics, but by and large the animal is so expendable that replacement would seem logical if only on grounds of economy.

Miscellaneous Infections

Coccidiosis is not uncommon in both guinea-pig and hamster. The usual classical symptoms of weakness with diarrhoea and dysentery are demonstrated, which respond rapidly to oral administration of sulphaguanidine 10 gr. three times daily. The infective organism is *Eimeria caviae*, and a history of polyuria should be regarded as suspect.

Balantidium coli has been isolated from several cases of illness in guinea-pigs, but its significance is doubtful. Ibsen has also had experience of a rapidly fatal disease involving the intestinal tract when "tremendous numbers" of *Balantidium* were observed.

Wet tail disease of hamsters seems to be increasing. Little is known of the aetiology of the condition. The symptoms are that the animal appears damp on its back anterior to its buttocks, and down its flanks. There is progressive dullness, sometimes with abdominal tympany, followed by death in two or three days. The writer has no experience of the disease, but from personal communication with a number of owners the disease seems to arise in closely bred stock after some generations. It would appear to be transmissible and to be connected with urinary function. Culling of affected and related stock, plus rehousing, has produced good results, but much work remains to be done on the disease.

Virus infections of guinea-pigs are well known to laboratory workers but do not seem to affect the individual. Infectious paralysis, the salivary gland virus, epizootic hepato-enteritis, are well described by Hughes (1947). Pearson & Eaton (1940) refer to a virus pneumonia of hamsters which is usually fatal in 6 to 15 days.

Ectoparasitism

Clearly both hamsters and guinea-pigs will be susceptible to flea, louse, and tick infestation from infected bedding. They will, however, indicate this very rapidly since they are both avid groomers and will pay excessive attention to their coats if they harbour parasites. The usual insecticides can be used with safety, and exactly the same procedures should be followed with their cages as for any other species.

Hindle (1947) describes notoedric mange in hamsters caused by notoedres as being a disease spreading from the ears to other parts of the body. He claims "Mitigal" or "Tetmosol"* to be effective in treatment.

Wounds

Typical of all rodents, hamsters and guinea-pigs can inflict severe wounds upon each other with their powerful front teeth. The importance of these wounds is that if left unattended they invariably go septic and can rapidly produce a generalised septicaemia although the original wound may appear minute. All such wounds should be cleaned and dressed most carefully.

Generally speaking, veterinary attention to individual animals will be limited by the ratio of cost of treatment to cost of replacement. It is of importance, however, where many animals are kept, and also when a young owner turns to the veterinary surgeon for assistance for a pet which, to him or her, is invaluable and irreplaceable.

* I.C.I. Ltd.

TORTOISES

Tortoises are reptiles and belong to the order *Testudinata*, which includes tortoises, terrapins, and turtles. There are several species of *Testudo*, which come from the Mediterranean shores, but the two most commonly seen in this country are the Mediterranean spur-thighed tortoise and the Hermann's tortoise. Both are loosely referred to as the "Greek" tortoise, though neither is indigenous to Greece. The description "Greek" is probably due to the fact that the Greeks first described the animals. All are familiar with the horny case of the animal protecting the soft tissues. The dorsal domed sheel is known as the carapace and the ventral as the plastron; both are segmented into shields, all of which are named according to position and assist in defining species.

Determination of sex

The tail in the male is long and pointed; in the female short and fat.

The marginal shield covering the tail in the male is rounded and turned under. In the female it is somewhat flatter.

The plastron is more concave in the male than in the female.

Diet

Tortoises are vegetarian and enjoy a very mixed diet to include lettuce, cabbage, grass, seedling plants, watercress, dandelion, chickweed, tomatoes, fruit, etc. Individuals may have a taste for bread, but this should not be encouraged. They need drinking water from a low-walled heavy vessel, or of course from a shallow pond.

Hibernation

Tortoises in this country hibernate from about October to March. The period of time is dependent upon weather conditions and air temperature. The creatures can perfectly well hibernate out of doors, when they will bury themselves under a bush or like place, but run the risk of accidental injury or disturbance. If artificially hibernated indoors, they should be placed in a box (among newspaper, straw, or leaves) in a dry place where the temperature remains constant and low. A broken hibernation can be dangerous to the animal. This point will be discussed later.

SUMMARY

I. Injuries.
II. Infections.
III. Parasites. (a) Internal. (b) External.
IV. Surgical.

Injuries

Those to the carapace or plastron are frequently seen in the newly imported animal as the result of bad shipping and packing. Depressed shields should be pulled out, and secondary sepsis treated clinically. Extra warmth assists recovery. Leg fractures are most difficult to cope with due to the animal constantly trying to retract the limb. In order to splint a limb, and to overcome retraction, torpidity can be induced by placing the animal in a domestic refrigerator for 30 minutes or so. No harm will come of this procedure.

Infections

Generalised infection of the lungs and intestinal tract is commonly seen in the spring as a result, in the writer's opinion, of inferior or disturbed hibernation. The writer disagrees with Noel-Hume (1954) who subscribes to the theory that a broken hibernation is not dangerous, and also claims that should it occur (or have occurred unnoticed for some time) the animal should be kept warm and fed for at least 14 days. The writer considers that in a case of broken hibernation it is better either to cool the animal back into hibernation, or to keep it warm and feed it constantly to stop it hibernating.

Symptoms and diagnosis

The first thing the owner usually notices is naso-ocular discharge. There may also be wheeziness. Treatment consists of raising body temperature either by warmer surroundings or, as an emergency, by submerging the animal in warm water, keeping the head out. The removal of discharges, combined with antibiotic injections with a spreading agent, frequently produces a cure. The dose is 10,000 units of crystalline penicillin subcutaneously in the brachial region twice daily. It is desirable to administer 10 drops of vitamin B_{12} daily to stimulate the metabolic rate: even if this is weak in theory it seems to be beneficial in fact. Noel-Hume suggests friars balsam inhalations as an adjunct.

Local Infections of the eyes and mouth are not uncommon sequelae of hibernation. The eyes become blocked with a caseous discharge together with conjunctivitis and sometimes a corneal opacity. While local treatment is essential, it is well to remember that the condition is probably secondary to poor health. Similarly, the mouth may become clogged with a like material, which can layer the gums and dental plates. This should be removed, the inflamed areas treated with a disinfectant, remembering that carbolic disinfectants are contra-indicated. On several occasions when this cheesy material has been examined, a low-grade staphylococcus has been isolated.

Parasites

(a) *Internal.* Tortoises suffer from roundworms which are voided via the cloaca, or occasionally vomited. They do not seem to suffer from these infestations, but the owner is frequently keen on treatment. A quarter of a tablet of diethylcarbamazine acid citrate* daily for seven days has produced a successful clearance without any side effects.

(b) ***External.*** Newly imported animals sometimes arrive with ticks adherent to their necks and soft tissues. These can be plucked off using a drop of chloroform to stupefy the tick.

Surgical diseases

The writer is familiar with two conditions which readily respond to surgery: pedunculated lipo-fibromata, and prolapse of the penis.

Pedunculated lipo-fibromata are quite commonly seen around the neck of tortoises. They can mechanically interfere with extension and withdrawal of the head and frequently become ulcerated and infected. They can be removed quite simply under local anaesthesia whilst holding the animal's head out gently with a pair of whelping forceps of suitable size.

Prolapse of the penis is really the result of inability on the part of the male to withdraw the organ back into the cloaca after an erection. This is usually because it has been injured whilst erect, and the subsequent oedema prevents its withdrawal. Due to the resultant haemostasis, the condition becomes progressively worse. If simple lubrication and manipulation are insufficient to produce a cure, the penis can be amputated under local anaesthesia. The penis does not carry a urethra, there being merely a dorsal channel for transmitting semen. Thus, amputation is simply carried out by ligation and removal of the organ distal to the ligature.

Summary

In the course of this paper the writer has endeavoured to cover, from the clinician's point of view, some of the common diseases affecting cage birds—typified by parrots, budgerigars, and canaries—and other unusual pets, typified by the monkey, hamster, guinea-pig, and tortoise. No claim is made that the paper is comprehensive or detailed, but an endeavour has been made to draw the clinician's attention to conditions occurring in these animals which are readily diagnosed and, in some cases, worthy of treatment.

Acknowledgments.—The writer's thanks are due to the Director, Zoological Society of London, for permission to publish this paper; to Miss Raymer and the staff of the Royal College of Veterinary Surgeons' Library; the staff of the Royal Veterinary College Library; the Royal Society of Medicine Library; Mr. Stratton and the staff of the Zoological Society of London Library; the writer's secretary, Mrs. Heritage; the Secretary of the British Veterinary Association; the Editor of THE VETERINARY RECORD and staff.

A Bibliography to this paper will be published shortly in the body of THE VETERINARY RECORD. The Editor regrets that it was not available in time for publication with this issue.

THE SPEAKER'S INTRODUCTION

The Chairman (Mr. S. Jennings) in introducing the author, said that the general public heard of the subjects which were discussed at the Association's meetings and it was as well they should know the profession took an interest in all types of animals including wild or semi-wild animals and birds. Perhaps emphasis of that aspect put the lowest possible value on the paper for the profession were genuinely interested in all types of animals and birds. They knew that Mr. Jones was very capable of presenting the paper.

* Banocide.

and because he had done so at short notice they were particularly obliged to him. The paper was one of great interest.

Mr. Oliver G. Jones: "I am very flattered by your opening remarks, Mr. Chairman, and I am particularly glad that you mentioned the paper was produced in a hurry. That in part may explain some of the inadequacies which you have probably noticed in it. It was extremely difficult constructing a paper for this title. The word 'common' entails a lot of careful thought in that it is very much more important in my opinion to know what to leave out rather than to know what to put in. The result is that I have left a lot of things out, some of which should have been put in. Because of the term 'other less usual pets' I decided to include monkeys, hamsters, guinea-pigs, and the tortoise because those seem to be the animals we are questioned about most frequently at the Zoological Society. It is impossible to include the variety of creatures one may be called upon to see at circuses.

"I think I have not stressed sufficiently the use of radiography as a diagnostic aid. Perhaps this is partly due to the fact that at the London Zoo we have not at this moment got a machine. There are difficulties associated with the various types of patient. It is desirable to take routine X-ray pictures for a large collection such as we have at London. I have in mind the diagnosis of tuberculosis in monkeys in particular. It should, however, be remembered that the advance of a disease is sometimes so rapid that there is very rarely any evidence of fibriosis calcification and therefore an X-ray picture is not likely to show any but the last stages of the illness.

"I have not made any mention of diseases of the tail of monkeys. Many of you will have had a monkey brought to you with an ulcerating tail. Various views are held as to how this condition occurs. Probably the most important cause is trauma, which leads to subsequent ulceration. Just as important may be irritations and wounds which are self-inflicted by the animal. The quickest and best way to deal with the problem is to amputate that portion of the tail which is affected, but that brings other problems in the healing of the wound. Provided the lesion is not so gross that bony tissue is exposed, one can apply a topical anaesthetic after treatment to prevent interference. The use of modern sedative drugs such as chlorpromazine in this respect is indicated and is very effective." (Applause.)

The Openers

Mr. J. A. Dall, in opening the discussion, said: "It is indeed a privilege and a pleasure to open a part of Mr. Jones's paper on mammalian pets and amphibia.

"I feel that this subject has far too long been neglected both by the profession as a whole and by the individual practitioner. Far too often the owners of such animals who came seeking advice have been turned away dissatisfied, not so much by a lack of knowledge, but by a lack of interest. Surely we as a profession are the best qualified to advise and to treat all animals, and since the 1948 Act, it is more than ever necessary to show ourselves willing and capable of treating not only those animals we wish to attend, but all animals, and birds for that matter.

"I must admit from the purely financial view there is a severe discrepancy between the time spent and the fee chargeable, but one can gain considerable prestige and sincere gratitude from a happy and satisfied client. I find that the owner in most cases appreciates to the full what you are trying to do and knows only too well the difficulties there are in treating these tiny animals.

"After I had accepted the B.V.A. invitation to open this paper, I wondered why they had asked me as I have no real qualifications other than an intense interest in the subject and perhaps the little experience I have gained at the expense of the inmates of a zoo. I fully realise how inadequate my knowledge is, but no one can ever say that I do not try to treat everything, and anything, that comes under my care, to the best of my ability. Sometimes, with a success that staggers me, and at other times with failures that depress me. I would earnestly suggest to all practitioners that it is far better to have tried and failed than never to have tried at all.

"As I have said, my failures have been many in both surgical and medical treatment, but without exception no one has ever taken me to task over this—rather the reverse—and one gets more and more peculiar pets to deal with, sometimes from astonishing distances away.

"Mr. Jones has stressed that this paper is purely clinical, and in so doing has, in my opinion, stressed the importance of it. We all know that due to the research worker and pathologist there is a wealth of pathological data, unfortunately, most of it not readily available to the practitioner, and much of it unrelated to any clinical entity.

"He has wisely restricted his paper both in the number of animals and in the number of diseases dealt with. As is indicated in the paper, diet, hygiene, and preventive medicine are so much part and parcel of disease in these small mammals that it is very difficult to know where to draw the line, and in both diagnosis and treatment faulty diet, housing, etc., play a vital part, and the subject could well form the basis for a whole series of papers.

"I would agree with Mr. Jones that in the main the pet owner is really considerate towards the pet, but the surprising and often abysmal lack of the most rudimentary knowledge of animals has to be seen or heard to be believed, and frequently a mistaken kindness is tantamount to exquisite cruelty. Their ideas of husbandry are often so obviously erroneous, that there is no difficulty in offering advice, but frequently the owners are dubious of altering these methods as a so-called expert, a mythical 'someone,' who knows all about animals, has told them to do this or that. It is really amazing how these so-called experts flourish when the profession is chary of offering advice, and again I wish to stress this point at the risk of being accused of repeating myself. Who is better qualified to advise than the veterinary surgeon? Even if the specialist requirements of the animal under consideration are unknown, all of us have the basic knowledge for a maintenance of health and well-being, whatever the animal.

"Mr. Jones has covered the common diseases so thoroughly that it does not leave very much for the opener to discuss, but I would like to emphasise one or two points which to me are vitally important. The pets dealt with in this paper are readily shocked and are highly sensitive to any change in routine, and to actual strangers. It is essential, if one is to observe the animal correctly, that a short time should elapse so that it may settle down. I use this time to endeavour to get the history from the owner, and I can assure you it gives more than ample time in most cases. I, too, prefer that the owners handle the pet themselves if it is necessary, and I try to be as quiet and slow moving as I can, particularly when approaching an animal that is already being restrained.

"After my examination, and taking into consideration the history, I try to decide into which of three categories the condition falls primarily:—

1. Bacterial, viral, or protozoon infection.
2. Environmental.
3. Psychological.

"In 1, I include the pneumonias, dysenteries, the septicaemias, and any of the specific infections of the particular species.

"In 2, I include those conditions which are due to faulty diet, housing, and hygiene (this includes the deficiencies), and in 3, such conditions as show that the animal is definitely affected basically by a lack of certain amenities which are essential for its well-being; for example, the lack of a darkened den, *i.e.* no place of concealment, giving it a sense of security; bullying between individuals of the same or different species; over-handling by the owner, etc.

"Frequently, however, it is impossible to classify the condition into any one group for often more than one factor is at work.

"I heartily agree with Mr. Jones that every laboratory aid should be utilised to the full to confirm any clinical findings, and I also agree that to treat any of these animals satisfactorily it must be done quickly owing to their high metabolic rate, and consequent rapid deterioration. I am inclined to use antibiotic therapy purely empirically in the first instance.

MONKEYS. "The monkeys I normally see are the inmates of the Zoo, and consequently are practically impossible to handle. I have nothing to add to the excellent and detailed methods of restraint and anaesthesia in the paper. I myself feel safer when I give pentobarbitone intravenously. Thiambutene HCl used at double the accepted subcutaneous dose, namely, 100 mg. per 5 lb., is reasonably useful as a sedative.

"Chlorpromazine HCl has in my hands proved rather unreliable, but this may be due to under-dosage.

"I have had little experience of tuberculosis; I am certainly not in a position to add anything to that which is in the paper, and I would like to congratulate Mr. Jones on this part of his paper in particular.

"In treating diarrhoeas and dysenteries I am also of the opinion that antibiotic treatment combined with palliatives and starvation is the wisest course. Recently I have used chloramphenicol palmitate with excellent results, but I am inclined to disagree with the intraperitoneal use of pentobarbitone in such cases where there is excessive pain—I rather prefer Chlorpromazine HCl.

"I would like to mention in passing that among the human ailments I have seen in chimpanzees is that of mumps, which could easily be mistaken at the beginning for a bacterial infection of the glands.

"Colds due to actual chilling or marked temperature fluctuations can and do result in severe respiratory troubles, and I would like to emphasise the importance of heat and humidity in this condition. If possible I prefer a temperature of 85° F. as a minimum: it must of necessity remain constant within a degree or two. For treatment I have recently been using oxytetracycline HCl in preference to penicillin or hydiodide of penicillin, and as a local nasal treatment I find Sulfex (Menley & James) highly satisfactory. Most monkey invalids will invariably take grapes in preference to anything else.

"When the necessity has arisen to suture monkeys, I have used very fine steel wire with Halsted's suture with some degree of success. I cut the ends very short, but I have rarely found the use of an anaesthetic dressing satisfactory. I use Nobecutane plastic dressing. To avoid interference, it is useful to apply sellotape to other parts of the body so that most of the time is taken up in attempts to remove this rather than the sutures. A sedative mixture such as Mr. Jones suggests is excellent, depending on whether it can be given easily or not.

"I am convinced that monkeys in this country, both in zoos and in private homes, suffer from more or less severe deficiencies and, as one would expect, these are more marked in the young. In most cases they are associated with a relative rather than an absolute deficiency of vitamins A, B, D, and E, and the Ca:P205 ratio is frequently far too wide in the growing animal.

"I use as supplements liver extract, calciferon, radiostoleum, vitamin A, α-tocopherol, mixed vitamin syrups, and vi-daylene and di-calcium phosphates. I do not use cod-liver oil as I am never quite sure whether the vitamin content remains constant for any length of time. I have not used infra-red or ultra-violet lamps as curative agents, but I feel sure that they would prove of great value in the condition of cage cramp and hind-leg paralysis of marmosets. I have never had any success whatsoever in treating fits in monkeys.

GUINEA-PIGS and HAMSTERS. "There is little that I can add to the notes on guinea-pigs and hamsters except to stress the value of the nitrofurazones in enteric infections and Gamma B.H.C. in miscible oil in the treatment of mange and ecto-parasites. I use the latter in the form of a spray.

"There is a condition that I have come across several times in guinea-pigs where the diet has been deficient in oats or bran with an excess of green succulent foods where the animals suffer from a locomotor ataxia and eventual death. In both instances one large injection of vitamin B_{12} (250 mg.) and vitamin B_1 (50 mg.) cured the condition in a few hours. Needless to say, the diet was altered to contain a sufficiency of oats, bran, and hay.

TORTOISES. I find that injuries in tortoises respond well after cleansing and debridement to the painting of the wound with chloramphenicol tincture, covered with a spray of Nobecutane. Local infections of the eyes and nose respond well to cleaning; for this I use liquid hammamelidis in high dilution, plus the subsequent instillation of antibiotic drops or ointment.

"Post-hibernation infections seem to respond very satisfactorily to Terramycin orally. It may be that my lack of success with injections of penicillin was partially due to my not using a spreading agent. I also administer a tonic in all local and generalised infections, and I consider that extra warmth is essential for a satisfactory cure.

"For internal parasites in tortoises I still use as a vermifuge 1 grain of santonin to 5 lb. weight with excellent results. This treatment is repeated at weekly intervals if required.

"In closing, I hope that this paper will stimulate in the profession a new outlook towards strange pets and their sometimes baffling diseases, and I hope that in the near future we will be in a better position to give the public the service that they are entitled to."

Dr. J. G. Campbell said: "I feel that I am here almost under false pretences in that, while I used to be in charge of a poultry diseases diagnostic department at the Edinburgh School, I have now been away from the subject for eight or nine years and I am rather out of touch with many of the more recent developments. I was very impressed by Mr. Dall's remarks and his use of drugs which only eight or nine years ago we did not have.

"Now I must congratulate Mr. Jones on his most excellent paper. He has obviously put a great deal of work into its preparation and it should be quite invaluable to the practitioner confronted with an unusual patient in the form of one of these pets under discussion. I am not qualified at all to speak about many of the animals mentioned in the paper. Being in a poultry diagnostic department, naturally poultry were the main animals we dealt with. We had the odd creature brought in occasionally, such as a reptile, or even a fish, but I have had practically no experience with monkeys, except once in practice when one was brought in for amputation of the tail, the tip of which had gone gangrenous. We were out when the animal came and when we arrived back there was a tremendous uproar and crashing of bottles. The monkey had got loose in the pharmacy and the chaos created in 10 minutes had to be seen to be believed. Then the attendant had an epileptic fit. That is my only experience of monkeys.

"I feel that there is really no excuse for the general practitioner to show lack of enthusiasm in treating diseases of cage birds. After all, most of the conditions they exhibit are more or less equally shown by poultry, and in an ideal veterinary curriculum poultry diseases should be dealt with very thoroughly, since economically they are the second most important representative of farming livestock in Britain. Unfortunately, however, I am afraid the diseases of poultry is a much neglected subject. It is true that some of the colleges give a short poultry-disease course, but even then the subject is not treated as its importance deserves. It is a great mistake when you consider the position of poultry in this country, and it is obvious that adequate training should be given. If one has a fundamental knowledge of poultry diseases—and they are to the uninitiated rather curious in many cases—I think one could tackle with a fair degree of confidence the diseases of cage birds.

"I believe it is also true to say—and I say it with regret—that some practitioners rather disdain treating these creatures. The position seems somewhat analagous to that of a generation or so ago when veterinary surgeons would not deign to treat a cat or dog. They considered it rather below their dignity, their proper patients being the large animals, horses and cattle, and so on. There is now, however, a greatly increased interest in small animals. One realises they do serve a purpose and that although economic considerations do not necessarily enter into it, they are often of immense emotional value to their owners. The more we can do in helping these people the more respect we shall gain as a profession.

"Mr. Jones has pointed out, I think, that the attitude of not professing interest in birds is possibly due to a lack

of teachers and to deficient first-hand knowledge of the diseases. Possibly some practitioners are discouraged by what appears on the face of it to be a dearth of diagnostic symptoms. No doubt the diagnostic symptoms of birds as a class are more difficult to detect because of their size and structure than the kind of animals we usually deal with. A sick bird shows superficially the almost universal picture of depression, lethargy, and ruffled feathers, no matter what the illness may be. It is my opinion, however, that if one had a greater basic experience of their anatomy and diseases the difficulties of diagnosis would not appear so formidable.

"I have very little to say about the more particular aspects of the paper because to my mind Mr. Jones's presentation is practically above criticism. Some of the things I had in mind have been said already by Mr. Dall, so I shall not waste time by repeating them. I agree that the use of heat in treatment is most valuable. Such small animals lose heat very rapidly and it is therefore important to keep their body temperature up by the use of some form of artificial heating. A point to be remembered is their susceptibility to gas poisoning when using a gas heater.

"I have a certain interest in French moult, since collaborating in an investigation into this condition with a well-known budgerigar-breeder who is also a medical practitioner. Fledgling birds were sent to me by various breeders showing what I was assured was a typical picture of French moult. They exhibited a deficiency in feathering and what feathers they had were very bedraggled and the quill shafts, especially of the primaries, were full of black pigment. I found the pigment was dried blood and in this were a considerable number of mites. We found the seed from which the birds had been feeding was fairly heavily infested with similar mites. Destruction of these mites in the seed and on the bird seemed desirable and this was done by adding insect powder in the proportion of 1:5,000 of the seed and dusting the birds with Gammexane dust D.034, and we had very encouraging results. The birds quickly commenced to develop new feathers and in a large number of cases they eventually grew into healthy adult birds.

"A question I should like to ask Mr. Jones is whether he has ever seen coccidiosis in budgerigars. I have not, but I have heard reports of the condition being diagnosed.

"Turning to the subject of tumours in cage birds, I should like to draw attention to the budgerigar which is very prone to develop tumours, certain of which are extremely interesting. Some are amenable to treatment but there are many others of a malignant nature which rapidly kill the bird or necessitate its humane destruction. There is one condition, which probably Mr. Jones has seen, consisting of a rather moist and inflamed swelling at the base of the primary wing feathers or at the carpo-metacarpal joint. At first I thought the condition was a spindle cell sarcoma, since histologically it showed many fibroblasts. However, I quickly had doubts as to the accuracy of the diagnosis because I found on removal that they did not tend to recur and quite often a simple painting with iodine solution brought about a resolution of the condition. I came to the conclusion the lesions were really infective granulomata, but the name does not much matter; the point is that these swellings are often amenable to treatment.

"Other tumours which are rather interesting academically—and it is satisfying to give a diagnosis even if treatment is not possible—are the normal producing tumours of the gonads. One sometimes sees male birds brought in with a history that they have ceased talking, become lethargic, and developed an abdominal swelling. The owner may draw attention to the fact that the blue pigment has disappeared from the core at the base of the beak which has turned brown. In such cases one can with fair confidence diagnose a testicular sarcinoma with virtual cessation of androgen secretion, or Sertoli cell tumour secreting oestrogen. In such small birds surgical intervention is not usually practicable. Less common is the opposite effect when a female bird develops male characteristics. This is associated with a greatly enlarged abdomen, and at *post-mortem* examination one usually finds an ovarian tumour, or more specifically, an arrhenoma.

"We used to have a large number of parrots brought in for treatment. One, called Joey, had been several times on the Murmansk run with its owner, and had picked up an extraordinary vocabulary not entirely suited to female laboratory assistants. This bird had recurrent warts below the mandible. I was not aware at the time that warts in parrots were said to be associated with skin tuberculosis of human origin. I gave a local anaesthetic and removed the warts and the bird was all right for a few months, after which there was a recurrence. This occurred repeatedly. I should like to hear Mr. Jones's opinion on that and on the possibility of tubercular disease in the owner or the family, which might raise rather delicate issues. Is it possible to do a tuberculin test on a parrot?

"In an aviary where there are a large number of canaries one occasionally sees an outbreak of canary pox, and the question of vaccination may arise. I have never tried it because in the literature it is said to be unsuccessful as a rule. Can Mr. Jones tell us anything about vaccination against this condition in canaries? In the case of aspergillosis, I agree with Mr. Jones that there is so far no specific treatment. Mouldy food or litter should be burned, and a daily cleaning of food and water troughs with 0.5 per cent. CuSO should be carried out. Outbreaks may be controlled by the addition of $CuSO_4$ in 1:2,000 in the drinking water.

"In Edinburgh we had a lot of birds brought in with fractures. Very often someone would pull the clothes pulley when the bird was perched on it in the kitchen and the bird's leg would be trapped between the rope and the pulley wheel resulting in a compound fracture. Dressings and bandages should not be put on too tightly because of the risk to the circulation. In an emergency a gauze bandage soaked in water can be put on over a cotton-wool pad.

"Anaesthesia in small birds is very difficult. Even in hens I find barbiturates are extremely tricky things to use, in my hands at any rate. I have found that the border line between the dose to anaesthetise and the dose which kills is so narrow that I have given up using them and have reverted to using ether." (Applause.)

The General Discussion

Professor D. L. Hughes (Liverpool) felt he must say what an excellent paper Mr. Jones had given them at very short notice. There was an enormous amount of information in it and one hoped that when it was tidied up a bibliography would be inserted because that would be most useful. Inevitably, certain species had been left out, but it was rather disappointing that the pigeon was not included because it was a very common pet and a very important one. Especially in the north, racing pigeons were among the working man's hobbies and they certainly suffered from a number of conditions. One of them was psittacosis. There was a tendency to think of it exclusively as a disease of the psittacine bird, but it was more than that, and it was common in pigeons.

Recently in the north a young member of a family was sent to hospital with symptoms of appendicitis. When the girl entered hospital the symptoms were rather vague and then they became predominantly respiratory. Specimens were sent to the laboratory and she was eventually diagnosed as having psittacosis. When the housing of the family was looked into it was found that the father kept pigeons, and blood tests on the pigeons revealed one or two reactors to psittacosis virus. There was no doubt the wild pigeon, so common in most cities, also carried psittacosis virus. Sudden death sometimes occurred in adult birds from rupture of an enlarged spleen, and in some instances the splenomegaly was associated with psittacosis virus.

Could the author refer to ectoparasites in snakes? The complaints of an individual guinea-pig, the pet of a child perhaps, must be very difficult to diagnose. In the laboratory one always had the advantage of having a number of guinea-pigs and a picture could be built up of the problem in the colony as a whole. Unfortunately, however, the experience of the laboratory worker was not

always of much use to the clinician dealing with the individual animal. (Applause.)

Major R. C. G. Hancock (Hannington) wanted to repeat how much all of them had enjoyed the paper, which would be very helpful to him. Probably he had the largest practice among patients that were "unseen," in the country. Each day letters and phone calls were received by him about small pets, and all too often the story was given, "My vet. won't look at it." This paper might do something to remedy that. It was a rewarding thing and well worth while to take an interest in the small or exotic pets. Perhaps the pet one was most commonly consulted about in London was the budgerigar. Owing to the erection of so many big blocks of flats, in the East End of London in particular, the favourite pets now were no longer dogs and cats but the budgerigar, the canary, and tropical fish. At the clinic which he used to attend to keep his hand in, it was surprising the number of dockers who came in with budgerigars.

To be successful one must always find something for the owners to do with regard to treatment. That was a clinical rule his father always rubbed in to him. There was, for instance, the question of vomiting in budgerigars. There was a lot of talk about sexual urges, but all that the client needed to be told was to get a bottle of milk of magnesia, put 10 drops in the water daily and the bird would be all right in a few days. That was the sort of approach that required emphasising.

Lorexane was admirable for budgerigars, whether for French moult or not, but it must be used in limited quantities. One treatment was to tell the owner to get hold of a good insect powder containing Gammexane, take a little on the finger and smear it over the affected patches. For French moult he always advised a crushed-up yeast tablet in the food, *i.e.* the B vitamins.

It would be interesting to hear more about the lumps in the budgerigar. It was difficult to know whether they were tuberculous or neoplastic in nature.

There was a very good book by James Fisher* who was not unknown at the London Zoo, which was very valuable in advising people on the care of their pets. The original edition contained a lot about monkeys, but apparently the London Zoo, like the R.S.P.C.A., strongly disapproved of monkeys being kept as pets by the general public, and the post-war edition of the book contains no section on monkeys. So far as TB. in monkeys was concerned, it was said in relation to the enormous number that were being captured to be sent overseas, that the incidence might be 50 per cent. if they were caught near human settlements, whereas among those caught in the wilds it was only 1 or 2 per cent. The paper was intensely interesting and he hoped it would lead to an authoritative text-book written specifically to assist the general practitioner.

Mr. W. T. Harrow (Manchester) congratulated the author on the paper and said he had great admiration for the work being done by him in eliciting many unusual conditions. That was becoming more and more important. His reason for trespassing on the time of the meeting was that he might be able to help a little on the question of the toxicity of benzene hexachloride. Since its production after the war there had been a considerable amount of confusion over its nomenclature. "Gammexane" was a trade name for benzene hexachloride for general agricultural and industrial purposes. "Gammexane" Insect Powder sold in shops contained 0.5 per cent. gamma benzene hexachloride; "Lorexane" dusting powder contained 0.2 per cent. It appeared important that very small animals and birds should not be treated with much more than 0.1 per cent. of benzene hexachloride, and if "Lorexane" dusting powder was being used it was really a question of the amount of powder that was put on the animal. If a whole tin of it was put on a kitten it could kill it, but if it was put lightly on a small animal or bird it was quite effective.

* "Animals as Friends and How to Keep Them" by James Fisher and Margaret Shaw. Dent and Sons.

Mr. A. Mather (Torrington) asked whether the author could tell them the best way to destroy a tortoise.

The Reply

Mr. Jones, in reply, thanked both the openers very much for the courteous way in which they handled the paper. One thing was very pleasing and that was the way they both said that the treatment of pets of the variety being considered was a subject that should receive more attention by the profession as a whole. The profession was undoubtedly perfectly able and willing to treat these animals but initially they seemed to lack the support they looked for in the teaching schools. The teaching schools must have some responsibility for the difficulties practitioners might find themselves in. There was a case for teaching schools to have a course of lectures dealing with these animals.

There was a very large population of wild animals in the country which was not limited to those which had been mentioned that morning. What was the problem of the veterinary surgeon who was called upon by a travelling circus? Mr. Jones felt a sufficient answer to that was to point out that during the current week so far he had received a telephone call from Glasgow about a sick sea-lion, one from Liverpool about a sick Polar bear, one from the west country about a sick seal, and one from Maidstone about a sick elephant. That was not an indication he was an expert or otherwise; it was an indication that practitioners generally did not have the opportunities he had to come in contact with so many interesting conditions and perhaps they lacked the necessary education from the college at which they graduated.

Mr. Dall's remarks were fascinating. In particular the classification of diagnostic aids consisting of the three groups of investigation was to be admired. They formed a very proper method. Laboratory diagnosis was absolutely vital to success. Frequently illness was due to shock of handling or shock due to change of environment, etc. It was noteworthy that Mr. Dall used intravenous anaesthesia quite a bit, and it would be intriguing to witness the operation. It was sometimes difficult to carry out an intravenous injection on a small, struggling animal. The remarks made about the dangers of colds were very true, and the reference to the use of steel sutures was interesting. For tortoises, reference was made to the use of chloramphenicol as a treatment. It was a very good idea.

Dr. Campbell's words on cage birds were rather frightening because he was obviously an expert who also had considerable academic knowledge. As far as French moult was concerned, Mr. Jones had seen very few cases and the condition was very arguable. He had not seen any wing sarcomas in birds. Another fascinating point was the reference to cock birds' change of sex due to tumour of the gonads. It was a condition with which he was familiar, but so far he had not associated it with cancer.

It should be stressed that the paper was not written with aviaries of birds in mind. It was meant particularly to cover the individual bird brought to notice by the owner. Because of that many things had not been mentioned, including virus infections which could infect an aviary. Aspergillosis was a condition seen quite frequently, and Mr. Jones had yet to treat it successfully. He had, however, just introduced a new therapy which was being tried out with regard to anaesthesia. Barbiturates for birds seemed dangerous, but some people had confidence in them. Two Japanese workers had used chloralhydrate in a variety of birds, including pigeons and pheasants, and said they secured extremely successful anaesthesia with no risk whatsoever. He had not used it personally, preferring ether vapour.

Professor Hughes' remarks were most welcome. It was true that pigeons were not covered by the paper. The idea was contemplated but there was a danger of the paper getting out of hand. There was a big call for the treatment of sick pigeons. He himself had dealt with psittacosis quite frequently. Pigeon drives were held in the Gardens occasionally, and of those shot some had psittacosis. It was found in budgerigars also, and many times outside birds were found to have psittacosis lesions. It would

appear to be a condition that was much more common than people realised. With regard to ectoparasitism of snakes, all snakes coming into the London Zoo were wiped down with a rag covered with liquid paraffin as a matter of routine.

Major Hancock's remedy for vomiting was an excellent one. The observations in the paper were of course intended for the qualified veterinary surgeon and not for the owner, over the telephone. The remark about Fisher's book was noted.

Mr Jones said that he would like very much to take up the suggestion of writing a book on the same sort of subject, but he was not fully qualified to do that. He would rather see a symposium of veterinary surgeons so that all those people with greater experience could contribute. That would be very desirable. For the destruction of a tortoise he recommended the injection of 5 c.c. of chloroform deep in the pectoral region.

The Chairman (Mr. S. Jennings) said the meeting had displayed a great deal of interest in the paper and the whole subject. They were very much obliged to all the contributors and looked forward to seeing the publication in THE RECORD. (Applause.)

The Anatomy of Disc Protrusion in the Dog

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Introduction

THE detailed anatomy of the canine intervertebral disc has been described (King & Smith, 1955) and it will be necessary here to recall only the fundamental features. The mucoid nucleus pulposus is surrounded by a fibrous ring, the annulus fibrosus (Plate 1). The annulus consists of about 25 to 40 concentric rings or lamellae composed of collagen fibres. Each fibre joins the two vertebrae which enclose its disc. The nucleus pulposus is normally under pressure; this can easily be demonstrated in the cadaver, and also applies during life, for if the annulus fibrosus of the living dog is cut the nucleus escapes with considerable force (Keyes & Compere, 1932). Functionally the essential points are that when the disc is in perfect condition the mucoid nucleus pulposus is virtually a liquid and the fibres of the annulus are slightly elastic. It is generally accepted that this enclosure of a liquid within a circular elastic ring absorbs the shock of cranio-caudal compression and distributes the pressure evenly throughout the disc during spinal curvature (Fig. 1).

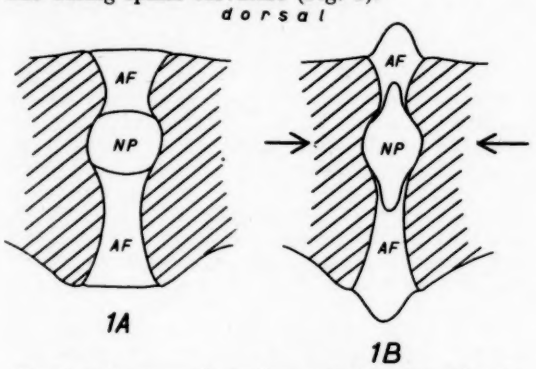
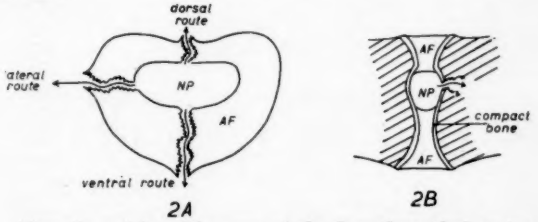


FIG. 1.—Diagrammatic median vertical sections of a disc to show how it absorbs shock. 1A.—Disc at rest. 1B.—Functionally perfect disc during compression, arrows indicating the direction of the forces. The mucoid, virtually liquid, nucleus pulposus (NP) becomes flattened and distends the elastic annulus fibrosus (AF) outwards. The arrangement resembles a thick-walled rubber ball filled with fluid and compressed between two hard plates. The bones are shaded.

A long series of researches, culminating in notable contributions by Hansen (1952) and Hoerlein (1953), has indicated that dorsal herniation of the nucleus pulposus, or dorsal disc protrusion, is a definite disease in the dog. It has been shown that in cases of pain, paresis, and paraplegia, except those where there is a definite alternative diagnosis (*e.g.* a fractured vertebra, distemper, etc.), projections into the neural canal can nearly always be found (Hoerlein, 1953). The varying sites of the projections can be correlated with varying nervous symptoms, and with corresponding lesions of the spinal cord (Hoerlein, 1953); reduction of the projections, by laminectomy or fenestration, often relieves the symptoms (Greene, 1951; Olsson, 1951). Finally Hansen (1952) and Hoerlein (1953) have revealed, from examination of hundreds of these projections, that commonly they are directly continuous with the nucleus pulposus of the intervertebral disc. In view of this array of evidence, which has been more fully analysed by Smith & King (1954), it is surely no longer reasonable to doubt that dorsal disc protrusion is a major cause of locomotory disturbance in the dog. It must be added that ventral and lateral protrusions, and protrusions into the body of the vertebra, can also sometimes occur (Fig. 2); their pathology seems still to be rather obscure, and they may have some connexion with spondylosis (see Hansen, 1952, for a review). Except where otherwise stated this paper is concerned with dorsal disc protrusion.



FIGS. 2A and 2B.—Diagrams of the four theoretical routes of protrusion. 2A.—Transverse section of a canine lumbar disc to show dorsal, lateral, and ventral routes of protrusion. 2B.—Median vertical section of a canine lumbar disc to show cranial (anterior) or caudal (posterior) protrusion through the compact bone of the epiphyseal surface into the spongy bone of the vertebral body (shaded). Abbreviations as in Fig. 1. The longitudinal ligaments are omitted.

The existence of a somewhat similar condition in man has been generally recognised for at least 20 years (Bradford & Spurling, 1945, p.6). The frequency with which disc protrusion occurs in man is also well appreciated, for it is the commonest cause of a very common and uncomfortable condition, low lumbar back-ache (Burns, 1951). Yet surveys of *post-mortem* examinations indicate that disc protrusion is at least as common in the dog as in man. According to figures quoted by Collins (1949, p. 266) about 15 per cent. of 368 human spines had protrusions. Hansen (1952) found them in about 16 per cent. of 561 dogs, and Hoerlein (1953) found them in 41 per cent. of 130 dogs. Of course, nothing like this proportion of the canine population are clinical disc cases; Hoerlein (1953) estimated that of the animals seen in a small-animal practice about 0.5 to 1 per cent. would be clinical cases of disc protrusion. Nevertheless it must be remembered that locomotory disturbance, which is the main clinical symptom in the dog, is an objective symptom—the dog cannot always tell us of subjective symptoms like back-ache.

The anatomist is perhaps in a privileged position in the field of disc protrusion because the pathogenesis of this disease in both dog and man depends unusually closely on functional anatomical factors. Thus, for example, he can aid the clinician and pathologist by offering the rationale for the predominance of the dangerous dorsal route of protrusion which damages the spinal cord and causes nervous symptoms, for the relatively high incidence of protrusions at certain ages and in certain breeds, and for the physical conditions under which the body seems to be most vulnerable to protrusions. These factors, macroscopic and microscopic, have been gradually discovered by the anatomists and morbid anatomists who have studied the intervertebral disc. Beadle (1931), Joplin (1935), and Coventry, Ghormley, and Kernohan (1945a, b), revealed vulnerable points in the human disc. The same has been done for the canine disc in a most outstanding manner by the Swedish pathologist Hansen and his clinical colleague Olsson (Hansen, 1952; Olsson, 1951). Many of these factors are common to both species, but apparently no one has attempted to compile a full list.

To make a full list of the major anatomical factors in the dog is the objective of this paper. This entails a review of the relevant contributions by previous workers on the dog. It is also a help to draw from time to time on the far more abundant anatomical, pathological, and clinical studies of the human disc; this is because sometimes these are now sufficiently complete to reveal directly how an anatomical factor is translated into pathological and clinical manifestations. Finally, as a personal contribution, one new potential factor will be offered which seems to have been overlooked hitherto, and another factor, the conjugal ligament, will be critically reassessed in the light of new information. It is hoped that this more complete analysis of the anatomical factors in canine disc protrusion will be useful to pathologists and clinicians in studying their own particular aspects of this disease.

Basic Factor Predisposing to Protrusion

The average man can detect the subtle signs of senescence, *i.e.* growing old, in several parts of his body during or after the third decade. But there are few structures which age earlier in life and with more certainty than the intervertebral disc. In the normal human disc the nucleus pulposus begins to lose its pristine mucoid structure in the third decade, and by the fourth has been largely replaced by fibrous tissue (Peacock, 1952); simultaneously the lamellae of the annulus fibrosus tend to separate and break into pieces (Coventry *et al.*, 1945b). Similarly, in the normal dog, from the age of one year collagen invades the nucleus and eventually makes it fibroid. This process is advanced in some two-year-old dogs and in over 50 per cent. of seven-year-old dogs; there is also a tendency for loosening and fragmentation of the lamellae (Hansen, 1952). Thus during early middle-age the nucleus pulposus is becoming less resilient and the annulus weaker; this renders the disc progressively less and less able to perform properly its function as a shock-absorber, and escape of nuclear material by penetration or even bursting of the annulus becomes increasingly likely. In the so-called chondrodystrophoid breeds (Pekingese, Dachshund, French Bulldog, and perhaps the Cocker Spaniel) these changes are abnormally accentuated so that by one year of age the nucleus pulposus has been converted into a hard chondroid mass (Hansen, 1952).

These adverse changes in the disc progress to an advanced condition while the rest of the body remains relatively young and still capable of maximum physical effort. From this one might expect the incidence of clinical protrusions to be greatest in the middle-aged animal because then the senescent changes in the disc are very advanced and yet the body is still fully active. The incidence of clinical cases of (lumbar) protrusion at different ages has been exhaustively studied in man: as expected, there are many cases in the third, fourth, fifth, and sixth decades, but the greatest number occurs in the fourth decade (Bradford & Spurling, 1945, p. 72); the number is reduced in the seventh and eight decades when ageing of the rest of the body has compelled a decline in physical activity. This relationship has apparently not been investigated in the dog on a comparable scale but the available evidence again points to middle-age as the danger period; thus of 46 clinical cases studied by Hoerlein (1953) the great majority were three to five years old and relatively few were over six. It might also be expected from the nature of these changes in the disc, that some violent or unexpected physical effort would be the immediate cause of the nucleus pulposus bursting out of the disc. Again the wealth of literature on the human disc has enabled this relationship to be determined; about 50 per cent. of all the recorded cases have followed gross physical efforts, such as lifting a heavy object in a bent forward position, and in many other cases mild strains like slipping have been a factor (Bradford & Spurling, 1945, p. 72). The fact that about 80 per cent. of human cases are in males (Bradford & Spurling, 1945, p. 101) is further evidence for the importance of physical strain in precipitating protrusions in man. It can be deduced that it is of parallel importance in the dog, but as yet there is little direct evidence. The difficulty is that the owner seldom witnesses the actual onset of symptoms: as Hoerlein (1953) put it: "When the question is placed before the owner as to how this occurred, the most frequent answer is to the effect that the dog was fine yesterday but was found in this condition this morning." Hoerlein (1953) did find that "occasionally" a sudden movement was known to mark the onset of symptoms. Olsson (1951) investigated 50 cases of paraplegia and found that five were definitely preceded by trauma or great physical strain, and that in seven others, which had shown mild preliminary symptoms for some time, the paraplegia was "oftentimes" initiated by jumping. There seems to be no clear sex difference in the incidence of protrusions in the dog (Hansen, 1952; Hoerlein, 1953), but this is not surprising for presumably the male and female are equally active physically.

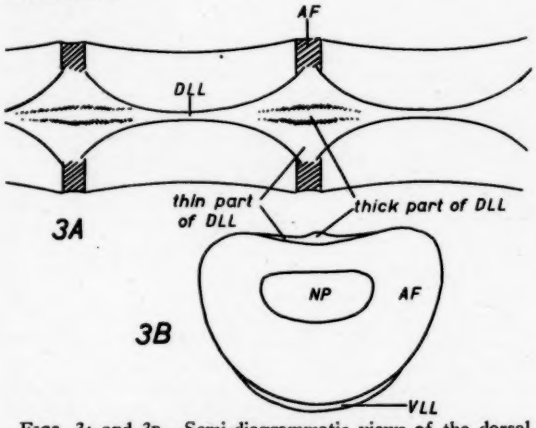
To sum up, there is no doubt that this early anatomical change in the disc of the ordinary dog is the underlying factor which often leads, in the prime of life, to the frankly pathological state of disc protrusion. The abnormal acceleration in these changes in the chondrodystrophoid breeds explains the relatively very great incidence of protrusion in Dachshunds, Pekingese, etc.

Factors Predisposing to Dorsal Protrusion

As soon as these senescent changes in the disc have occurred it is possible for the nucleus pulposus to bulge or burst out of the disc in several alternative directions, *i.e.* dorsally, ventrally, laterally, cranially (anteriorly), or caudally (posteriorly) (Figs. 2A and 2B). Yet in a dog the dorsal route is undoubtedly very much the commonest, and this is chiefly because of the following anatomical factors.

1. *The dorsal eccentricity of the nucleus pulposus.*

The nucleus pulposus is not in the centre of the disc but is dorsally eccentric, and therefore the ventral part of the annulus fibrosus is thicker than the dorsal—in fact it is about from one and a half to three times as thick. The lateral part of the annulus is also thicker than the dorsal part, and in some regions of the spine is the thickest of all because of one or two giant lamellae on the outside of the annulus (Plate 1). This relative thinness of the dorsal part of the annulus, where it faces into the neural canal, is certainly the main reason why the dorsal route of protrusion is the commonest in the dog and very common in man also.



FIGS. 3A and 3B.—Semi-diagrammatic views of the dorsal longitudinal ligament (DLL) of the dog. 3A.—Dorsal view of the floor of the neural canal as seen at *post-mortem* after removal of the spinal cord. 3B.—Transverse section of a lumbar disc. VLL = ventral longitudinal ligament. Other abbreviations as in Fig. 1.

2. *The ventral longitudinal ligament is stronger than the dorsal longitudinal ligament.*

Both these ligaments are attached along the vertebrae, one ventrally and the other dorsally, and both blend with the outermost lamella of the annulus fibrosus (Figs. 3A and 3B; Plate 1). The ventral ligament tends to be stronger and wider and more closely fused to the disc; the ventral aspect of the disc, therefore, tends to be more strongly supported by its ligament than the dorsal. However, this feature seems to vary in individual dogs, and perhaps not too much should be made of it. Anyway, the ventral ligament is absent between the mid-thoracic region and the head. In man the ventral ligament extends to the head, and the human anatomists are more definite that it does support the disc far more strongly than the dorsal ligament (Joplin, 1935; Coventry *et al.* 1945a); therefore in man it very probably is an important factor encouraging dorsal protrusion.

The dorsal longitudinal ligament affects the course of dorsal protrusions in both dog and man. The dorsal part of the annulus is usually thinnest in the mid-line and therefore one might expect the large majority of dorsal protrusions to be median. Actually, in the dog, many protrusions are somewhat lateral to the mid-line (Hoerlein, 1953); the same applies to man, which explains why symptoms like sciatic pain are quite often unilateral (Collins, 1949, p. 267). The reason in both species is that, in its diamond-shaped expansion over each disc, the dorsal ligament is thick in the mid-line but becomes much thinner laterally (Figs. 3A and 3B). Therefore the annulus is strongly supported in the mid-line, and relatively unprotected for about 5 mm. on either side.

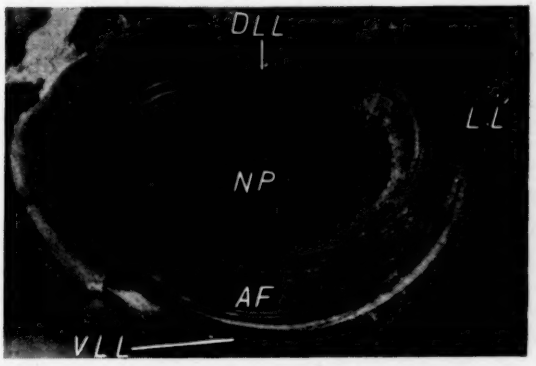


PLATE 1.—Mid-lumbar disc of a young adult greyhound after phenol-formalin fixation. Dorso-ventral height of disc in mid-line, 1.3 cm. The nucleus pulposus (NP) is still mucoid and makes a relatively distinct junction with the annulus fibrosus (AF); this is characteristic of the disc before senescence begins. Two giant lamellae LL' form the lateral wall of the disc. DLL = dorsal longitudinal ligament. VLL = ventral longitudinal ligament.

Factors Controlling Variations in the Incidence of Dorsal Protrusions in the Different Regions of the Vertebral Column

Although protrusions in the dog are not rare in the cervical region they are far more common in the early lumbar region and commonest of all at the thoracolumbar junction (Hansen, 1952). Hansen claimed that protrusions never occur in the dog from the eight discs between the first and ninth thoracic vertebrae; Hoerlein (1953) found a very small number of protrusions in this region. This distribution in the different vertebral regions cannot yet be fully ex-

plained but the following anatomical factors may exert some influence.

1. *Varying mobility and thickness of the discs in the different vertebral regions.*

It is reasonable to expect that a disc which is thick cranio-caudally (antero-posteriorly) and situated between two relatively mobile vertebrae will be more liable to protrusion than a thin disc between two relatively immobile vertebrae. This has been put forward as one explanation of the high incidence of lumbar protrusions in man, for the lumbar discs are relatively thick and lumbar mobility is relatively great (Bradford & Spurling, 1945, p. 15). But this is unlikely to be a very potent factor in the dog because in the lumbar region, where protrusions are most common, mobility seems to be minimal and disc length only moderate (King & Smith, 1955). However, in trying to assess the true significance of this factor, it must be remembered that measurement of the cranio-caudal thickness of the discs and especially of mobility are still in their infancy in the dog.

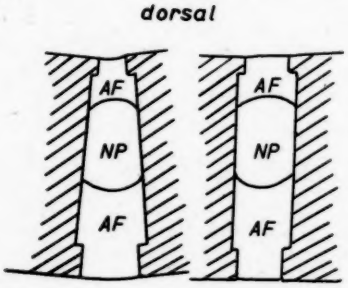
2. *Posture*

The site of the greatest strains and stresses within the vertebral column must be closely related in any species of mammal to its own individual posture at rest and in movement; these sites, in turn, almost certainly will have some relationship to the sites where protrusions are most common. But these relationships are not completely understood even in man where postural strains have been studied relatively fully. It can be shown that the upright human posture does impose progressively increasing forces of weight on the last lumbar discs (see Bradford & Spurling, 1945, p. 28); yet *post-mortem* surveys have shown that in man dorsal protrusions are just as common in the thoracic discs and early lumbar discs as in the last lumbar discs (Collins, 1949, p. 265). What are the forces in the vertebral column of the dog in different bodily positions and movements is not known at all; it is possible only to guess that the middle of the arch of the horizontal vertebral column, particularly where there are no ribs to give additional support, may well be subjected to the severest strains—this in fact is the region where protrusions are commonest in the dog (Hansen, 1952; Hoerlein, 1953).

3. *The varying thickness of different parts of the discs in the different vertebral regions.*

The factors discussed so far have all been more or less obvious and have often been mentioned before. One possible factor which apparently has never been discussed, either for the dog or man, is the variation in the cranio-caudal thickness of the different parts of the discs in the different regions of the vertebral column.

In man the dorsal flexion of the cervical and lumbar parts of the column is achieved by the dorsal part of the discs being thinner than the ventral, each disc being wedge-shaped (Fig. 4A); the ventral flexion of the thoracic region is almost entirely due to the shape of the vertebral bodies, the dorsal and ventral parts of the discs being, therefore, more or less equally thick as in Fig. 4B (Gray, 1946, p. 450). It surely is reasonable to regard the wedge-shaped disc in Fig. 4A as less vulnerable to dorsal protrusion than that in Fig. 4B, because the gap between the bones is narrower dorsally than ventrally. If so, one might expect fewer protrusions to occur in man in the lumbar and cervical regions than in the thoracic region. In fact, although lumbar protrusions are those most often diagnosed clinically, *post-mortem* surveys quoted by Collins (1949, p. 266) show that about two-thirds of all protrusions are found from the discs between the fourth thoracic and second lumbar vertebrae.



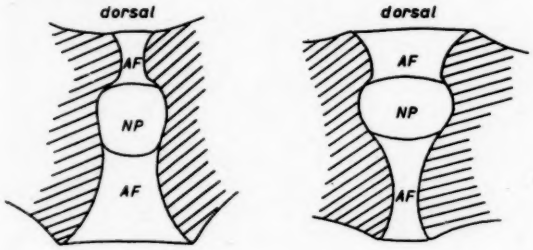
FIGS. 4A and 4B.—Diagrammatic median vertical sections of human discs to show the effect on the shape of the disc of the normal spinal curvatures. 4A represents the wedge-shaped discs in the cervical and lumbar regions where the vertebral column of man is dorsally flexed. These discs are thicker ventrally than dorsally. 4B.—Represents the discs in the thoracic region where the vertebral column is ventrally flexed. Here the thoracic discs are equally thick dorsally and ventrally. The bones are shaded. Abbreviations as in Fig. 1.

Apparently, varying thickness of the dorsal and ventral parts of the discs has never been described in the dog. We began a series of measurements to study this, but have had to postpone it until we have established the normal curvatures of the canine vertebral column.* Yet this may prove to be a more significant factor in the dog than in man, because the contours of the canine disc, imposed by the curved epiphyseal surfaces, seem to make the canine disc essentially more liable to dorsal protrusions than the human disc (King & Smith, 1955). For example the disc in Fig. 5B seems a great deal more vulnerable to dorsal protrusion than that in Fig. 5A. We hope to discover whether any regions of the canine vertebral column are composed of wedge-shaped discs like these.

4. *The conjugal ligament.*

This tough ligamentous band runs from the head of one rib to the head of the corresponding rib on the other side, passing closely over the dorsal aspect of a disc (Fig. 6). This arrangement, coupled with the apparent rarity of protrusions in the region where the ligament is present, led Hansen (1952) and Hoerlein (1953) to suggest that the conjugal ligament prevents dorsal protrusion from the discs which it covers. Hansen (1952) believed that the ligament was present

from the second to the ninth rib inclusive and therefore protected the eight discs between the first and ninth thoracic vertebrae. Hoerlein (1953) made no comment on this but quoted a personal communication from Professor Miller of the Cornell Veterinary School stating that the ligament was present on the tenth rib also. In absence of any authoritative statement in the text-books or literature we examined 74 dogs of mixed breeds and found that, in all but two, the ligament was present from the second to the tenth rib inclusive*: *i.e.* there are ***nine*** ligaments covering the ***nine*** discs between the first and tenth thoracic vertebrae.



5A 5B

FIGS. 5A and 5B.—Diagrammatic median vertical sections of canine discs to show the possible variations in the vulnerability of discs of certain shapes. A disc like 5B seems more liable to dorsal protrusion than one like 5A. The bones are shaded. Abbreviations as in Fig. 1.

Hansen (1952) found no protrusions whatsoever from the eight discs between the first and ninth thoracic vertebrae, and Hoerlein (1953) found only a very small number. Both authors, however, found a substantial number of protrusions from the next disc caudally, *i.e.* that between the ninth and tenth thoracic vertebrae: they found about as many protrusions from this disc as from each cervical disc and from each of the last two lumbar discs. Yet this disc is definitely covered by a conjugal ligament.

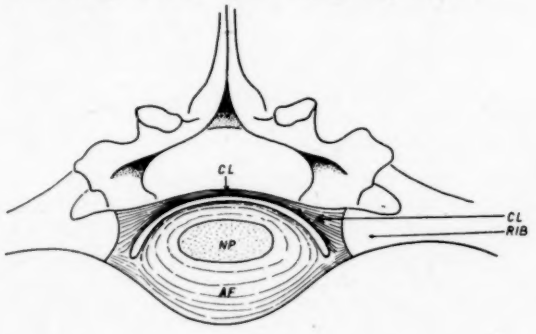


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FIG. 6.—Semi-diagrammatic transverse section of a canine mid-thoracic disc showing the conjugal ligament (CL) running over the disc between the two ribs. The longitudinal ligaments are omitted. Abbreviations as in Fig. 1.

* Work in progress at Bristol by R. N. Smith and A. S. King.

This fact indicated that the distribution of protrusions from the discs between the first and tenth thoracic vertebrae was not controlled simply by the presence of the conjugal ligament as Hansen and Hoerlein had suggested. Therefore I examined the conjugal ligament on 20 dogs and found the following new features of its anatomy.

The maximum dorso-ventral thickness (a) and the maximum cranio-caudal width (b) (Fig. 7) varied along the series of ligaments. The details will be given elsewhere, but the pattern was for a progressive increase in both measurements from the first to the fifth ligament, followed by a progressive decrease from the sixth to the last ligament. Thus the first and the last ligaments of the series were the thinnest and narrowest, and the fifth ligament was the thickest and widest. The latter averaged 1.7 mm. in thickness and 3.3 mm. in width, and the first and last ligaments were about one-third smaller. The first ligament was generally somewhat smaller than the last.

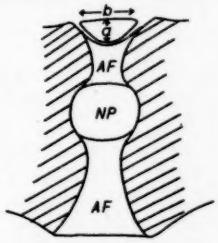

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FIG. 7.—Semi-diagrammatic median vertical section of a canine mid-thoracic disc. The conjugal ligament is in transverse section; its maximum dorso-ventral thickness is marked "a" and its maximum cranio-caudal width "b." Abbreviations as in Fig. 1.

It might be expected that the power of the conjugal ligament to protect the disc against protrusion would show some relationship to its size. Thus theoretically the middle of the series should show the minimum number of protrusions, and the number should increase progressively towards the two ends with the greatest number equally at the first and last ligaments. The distribution of protrusions actually observed by Hansen (1952) and Hoerlein (1953) bears no resemblance to this: the most striking difference is that, although a substantial number of protrusions was seen at the last ligament of the series, not one was found at the first ligament. I suggest, therefore, that the explanation for the distribution of protrusions in the conjugal ligament region, *i.e.* between the first and tenth thoracic vertebrae, is more complicated than Hansen and Hoerlein supposed, and that it must be controlled not by the conjugal ligament alone but at least in part by some other factor. I suspect this other factor to be connected with either mobility or posture.

Conclusions

From time to time attempts have been made to put the blame for the prevalence of disc protrusion in man on his upright posture (*e.g.* Splithoff, 1946), but the fact that protrusion also plagues the dog makes

one look deeper for the underlying cause. The basic factor, common to both species, is undoubtedly the extraordinary senescence of the disc while the animal is still in the prime of life. The result is that the nucleus pulposus loses its resilience and the annulus fibrosus simultaneously loses its elasticity and toughness—which can turn the originally shock-absorbing and cushion-like disc into a mechanism for firing pathogenic and sometimes even deadly projectiles. It is easy to see how the trigger can be set off by some severe physical strain especially in middle-aged animals since these are still capable of maximum bodily activity. In the chondrodystrophoid breeds these senescent changes are abnormally accelerated so that the disc is aged almost before the animal has had time to complete its puppyhood; this certainly explains the very high incidence of disc protrusion in Dachshunds and Pekingese and perhaps one or two other breeds.

The pathway of the projectile is unfortunately most likely to be dorsal, towards the spinal cord. This is chiefly because the dorsal part of the annulus fibrosus is only about half as thick as the ventral, but the different strengths of the dorsal and ventral longitudinal ligaments may also play a part.

Why some regions of the vertebral column are severely affected by protrusions while others are not remains very difficult to explain. Greater cranio-caudal thickness of the discs combined with greater mobility may prejudice the safety of certain regions, and so may a greater thickness of the dorsal part of the disc than of the ventral part making the disc wedge-shaped. Posture may be another factor. But very little is known about all these things. Even the relative infrequency of protrusions from the nine discs between the first and tenth thoracic vertebrae cannot yet be fully explained, for the fluctuating sizes of the conjugal ligament indicate that its presence alone cannot be the only factor.

However, further anatomical research, going hand in hand with clinical and pathological studies, should supply the answer to several of these problems, so that the time may come when few aspects of the mechanism of disc protrusion will remain beyond our understanding.

Summary

1. An attempt has been made to compile a complete list of the main anatomical factors controlling canine disc protrusion (herniation of the nucleus pulposus).

2. The basic factor leading to protrusion is the remarkably early senescence of the intervertebral disc. During middle-age the nucleus pulposus loses its resilience and the annulus fibrosus loses its strength and elasticity. Instead of absorbing shock the nucleus pulposus now tends to burst through the annulus, especially during severe physical strain. Middle-aged animals are particularly vulnerable because although the discs are aged the rest of the body is fully active. These changes are abnormally accelerated in chondrodystrophoid breeds and this accounts for the high incidence of protrusion in Dachshunds, Pekingese, etc.

3. The commonest route of protrusion is dorsal towards the spinal cord. This is mainly because the nucleus pulposus is dorsally eccentric in the disc, and perhaps also because the ventral longitudinal ligament is stronger than the dorsal.

4. The anatomical factors which cause dorsal protrusions to occur more in some regions of the vertebral column than in others are not clearly understood. The high incidence in certain regions may be due to a combination of greater cranio-caudal thickness of the discs with greater mobility, or to the stresses and strains of posture, or to a greater thickness of the dorsal part of the disc than of the ventral part. The distribution of protrusions from the nine discs between the first and tenth thoracic vertebrae is not controlled solely by the presence of the conjugal ligament.

Acknowledgments.—I have been helped a great deal by being allowed to utilise observations and ideas developed in this Department under Professor Ottaway's direction. I am particularly indebted to Dr. R. N. Smith, who has been working in this field longer than I have. This paper is really the product of our combined enterprise.

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THE SPEAKER'S INTRODUCTION

Dr. A. S. King, introducing his paper, said: "I would like to take advantage of this brief moment to talk about the alternative materials on which I have had to draw in preparing this paper, and the reason why I have selected some and rejected others. The task was to extract those aspects of the anatomy of the disc of the dog which could be brought to bear on the clinical problems of disc protrusion. There are two main problems which might be more or less soluble through an approach from an anatomical standpoint. Firstly, one could try to account for the pathogenesis, that is, to understand in anatomical terms why certain breeds at certain ages, under certain physical conditions tend to suffer from protrusion. Secondly, one could try to explain in anatomical terms the nervous symptoms seen in clinical cases of disc protrusion. However, I discovered that it would be impossible to attempt to solve both problems in the same paper, for I would fail to do justice to either. I had therefore to make a choice which was not difficult.

"It was obvious that to attempt to account for the first problem, the pathogenesis, was far easier than to attempt to explain the second. The first problem is really the first step, and so I thought it would be much better to consolidate as far as we could and account for the factors in the pathogenesis. Having put that on a firm foundation, we might be able to go into this question of the analysis of the symptoms. I will only say at this moment about the pathogenesis that I apologise if you feel that it is all too obvious. After I had written it I thought it must be obvious to everybody.

"With regard to the interpretation of symptoms, I do not know whether you will agree that this is an important fundamental difficulty. The surgeons in Sweden and in this country have now shown that we can do something for these clinical cases of protrusion by surgical means—I refer, of course, to the operation of fenestration. But I find in talking to friends in clinical practice that they say, 'Yes, that is all very well, it is fine to do this operation of fenestration but tell me how I know which disc to fenestrate!' It may be true that most disc protrusions are in the thoraco-lumbar region, but there are a lot of other discs which can still produce dangerous symptoms; how am I to know that I am not imposing on this animal, in addition to its inherent disease, a large number of surgical hazards? In the human subject the clinical neurologist can localise the precise disc which is affected by protrusion, in the majority of cases, by neurological tests. Figures quoted by Hoerlein from American sources indicate that about 60 per cent. of cases can be localised diagnostically to the last two discs. How is it done?

"It is done almost entirely by mapping the sensory changes in the affected limb. These changes are subjective, to a certain extent, in that the patient is able to say that there is a reduction of sensation in certain regions and accentuated sensation in others, greater pain in this position and less pain in the other. In the dog it is much more difficult to assess these subjective symptoms, but in addition to this there is an anatomical reason why I think it is going to be very difficult to sort out the nervous symptoms in cases of canine disc protrusion. In man the spinal cord ends at the region of the first lumbar segment, whereas in the dog it goes down to the late lumbar region. Incidentally, if one remembers this one might reflect how lucky man is that his cord ends at the first lumbar segment. The dangerous discs in man are the last two lumbar discs, and protrusions from these strike only the spinal nerves. In the dog most of the protrusions occur in the thoraco-lumbar region and these strike the lumbar cord, clearly the range of symptoms which can be obtained from concussion of the spinal cord is very much greater than the range of symptoms obtainable from spinal nerves, so that to isolate the precise disc in the dog is much more difficult.

"I hope in bringing forward this point that we might, among the many things which will be discussed, hear the findings of clinicians who have surveyed the neurological symptoms and checked them against *post-mortem* findings in cases which have had to be destroyed or have died. That would give us a lead as to how this problem can be tackled."

The Openers

Dr. Geoffrey Brook (Leamington Spa), introducing the discussion, said: "Having received a proof of Mr. King's paper I feel I have met him. When I finished the perusal I thought it was a very good paper and since then a rereading and analysis has confirmed my opinion. At one point he says it is hoped that this more complete analysis of the anatomical factors of disc protrusion will be useful to clinicians studying their own particular aspect of the disease. That is exactly what we want. We have reached the stage in practice where we have got tired of being confronted with this everlasting problem about which so little was known; what this paper does is to confirm us in our wish to tackle the problem afresh and gives us strength to face these worrying cases. They are worrying to the practitioner, to the owner and to the patient, so I do feel I can thank Mr. King for bringing this before us and congratulate the Committee who selected the subject for discussion.

"I want to talk about a few aspects of this business. The question of the definition of the site of the lesion is important. I am glad the author has stressed that, but I want to add to his statistics. I have not time to be an accurate statistician but we have kept a record of spinal paralysis in dogs in the last 10 years and during that time we have had 60 cases, six cases a year, or roughly one every two months. Comparing that figure with the number of small animals I see it comes to 4 per cent., which is far less than our Swedish friends meet in Scandinavia. This is a small country practice, possibly more than 60 per cent. of the patients are farm dogs, and I have not seen this condition in dogs which do the most work. I do not feel that this disease is the penalty of civilisation. Perhaps we can draw a parallel with the tired business man; he may be young in years but because of his employment he is bound to become overweight and any little effort gives him spinal trouble.

"In 90 per cent. of these 60 cases the age was between five and seven years old, but there is nothing fresh in that. With regard to the time taken to effect a recovery, the longest time was nine weeks, and generally I feel uneasy about the outcome of a case in regard to spontaneous recovery after the lapse of four weeks. The vast majority of patients on our list were Spaniels, especially the golden Spaniel. Next came the Sealyham, then Dachshunds, and then the Pekingese. We rarely have this condition in Pekingese although they are popular in this area.

"In regard to prognosis, I think the highest percentage of fatalities occur in the Sealyham and the Dachshund; many of the Spaniels recover but the Pekingese are the next most dangerous patients.

"The history of these cases is interesting. In the vast majority of cases we get no history whatever; all that the owner can tell you is that all was well the night before and the next morning these was complete paralysis. Occasionally the owner is able to confirm that during the preceding 24 to 48 hours the animal was noticed to be dragging the toes of one, sometimes both, hind legs. I was interested to find that although the final picture is bilateral, the premonitory picture is usually unilateral. This lends support to Mr. King's suggestion that if the condition is due to bursting out of the disc structure it does occur from one side to the other and, having occurred, there is general bilateral pressure on the spinal cord. Another warning symptom frequently referred to is the fact that the dog, which could previously run upstairs, refuses to endeavour to mount any obstacle, and especially is this so in regard to getting up on something; it is not so marked with regard to jumping down from something. I imagine that it is the raising up of the body from a bending posture which really causes the greatest difficulty, inconvenience and pain.

"We sometimes get the history of a sudden attack following some observed unusual physical effort, for instance, a dog saves itself from slipping on the steps or on the floor. Occasionally we get a history of unilateral trouble slowly developing into the crisis.

"I have never yet seen a case of complete unilateral paralysis. Either the dog has not become paralysed or both limbs are affected. For the first 72 hours it affects the bladder and the bowels, but at the end of that time both are restored to their normal function. Why this is so I do not know; it is one of the questions I want to put to Dr. King. Another point is that during this period the condition is extremely painful—one might say exquisitely painful—but after the passing of three or four days the pain disappears and coincidentally the bladder and the bowels also seem to recover their powers of working.

"Unfortunately for Mr. King's desire to see this site of disease determined and pinpointed, 80 per cent. of our cases recover spontaneously in the succeeding weeks. We never really give up hope until the ninth week has passed, although most of the ones which recover show promising signs within one month. Not only do I realise that we might damage a dog destined to recover anyway, which would be a very wrong thing to do, but we might also submit him to a somewhat grave physical stress in using these radiological methods when the condition was most painful. However, we have submitted five cases to radiology. In the first case there were no symptoms, but there was a very definite demarcation of the enlarged disc after injecting the sub-

arachnoid space. We had four cases which refused to get better and eventually I got the owners' permission to try to define the question as to whether or not the symptoms arose from compression paralysis. It is no use expecting to eliminate protrusion unless one is sure that it is present, and when the fluid passes down the spine and stops at a definite place it is evidence of compression paralysis. The sternomagna has to be tapped with a needle and that requires a lot of practice because one is putting into the delicate subarachnoid space a supposedly innocuous substance. The patient must be held vertical while the oil finds its level, all of which is a highly technical procedure and very troublesome.

"When we have got the information, we would like to know whether a dog which has been paralysed for nine weeks will benefit from the removal of the pressure by operation? Possibly the real answer lies not in the injection of oil but in the injection of air. If one injects air into a man it fills the space. When one inverts a dog the air goes up the subarachnoid space towards the tail and presumably might show the location.

"A long time ago I was reading a book on human neurology and the surgeon said that in his prayers each night he used this final supplication: 'Oh Lord, when thou takest me, take me not through my bladder,' so impressed was he by the agony which can be caused by the human bladder. I think we might say, 'Oh, Lord, when thou takest me take me not through my spine,' one of the few really painful conditions in dogs. Anything which will help us to investigate this problem will be of great advantage."

Mr. S. W. Douglas (Cambridge) said: "I, too, wish to congratulate Dr. King on the very able paper he has placed before us this morning. Anyone who is familiar with this condition in dogs, and has thought about it to any extent knows only too well that it is a subject which raises many as yet unanswered problems with regard to aetiology, pathology and clinical diagnosis, prognosis and treatment. In his paper Dr. King has set down the basic facts concerning the condition, thus laying the foundation on which in time may be built a more exact knowledge of this comparatively common disease of dogs. I cannot claim to share Dr. King's expert knowledge of anatomy and my humble claim to contribute to this discussion is based on the fact that, as a clinician, I have been interested in this subject for a number of years, and have been able to keep, and build up, detailed records of a comparatively large number of confirmed cases of protrusion of the intervertebral disc in the dog. (I use the term 'confirmed' for those cases that came to *post-mortem* examination, or in which the protrusion was seen at operation, or where there was definite evidence of a protrusion on X-ray examination.)

"As I have already indicated there are many aspects to this subject and, as my time is limited, I propose to deal with the clinical evidence which bears on the subject matter of Dr. King's paper rather than to wander to any extent into the wide fields of diagnosis and treatment. I realise, too, that the statistics which I shall put forward to correspond with the reports of Scandinavian and American workers and those just given by Dr. Brook, but I feel that they may be of some significance.

"Dr. King has emphasised that the major factor in the causation of the condition is a degeneration of the disc itself, rather than the result of direct trauma and this is certainly supported by clinical evidence. It is my experience that while symptoms are occasionally reported to follow a slip off a chair or a misjudged jump (the type of mishap which, incidentally, the dog has sustained many times before without injury), in about 90 per cent. of cases I have been unable to obtain any such direct history of injury. In contrast, one finds that when a dog with a comparatively normal intervertebral disc is subjected to severe injury—such as a car accident—it is usually a vertebra which fractures rather than the disc which gives.

"Dr. King has suggested that the highest incidence of disc protrusion might be expected to occur in the middle-aged animal. My records confirm this as will be seen in the first diagram (Fig. 1). This indicates that the commonest age for the occurrence of the condition is at four, five, and six years old.

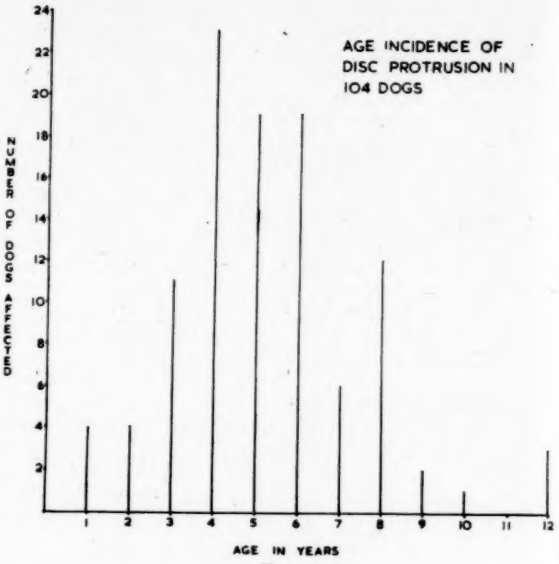

FIG. 1.

"To me one of the most interesting features of the condition is the very marked breed incidence; and the next table indicates the breed and age incidence for my materials (Fig. 2).

BREED AND AGE INCIDENCE OF DISC PROTRUSION

BREED	TOTAL NUMBER OF CONFIRMED CASES	AVERAGE AGE OF FIRST ATTACK
DACHSHUND	28	5·2 YEARS
PEKINESE	23	4·1 "
COCKER SPANIEL	16	5·0 "
SPRINGER SPANIEL	5	5·8 "
MONGREL	15	7·4 "
SEALYHAM	6	6·3 "
CORGI	3	5·0 "
MINATURE POODLE	2	3·3 "
BULL TERRIER	1	8·0 "
SCHNAUZER	1	4·5 "
SPANIEL × DACHSHUND	1	4·0 "
LABRADOR	1	7·0 "
ALSATIAN	1	6·0 "
SCOTTISH TERRIER	1	8·0 "
	TOTAL 104	

FIG. 2.

"It will be noted that Dachshunds, Pekingese and Spaniels account for over 70 per cent. of the cases seen. In addition, the incidence in these breeds is higher than in what is the commonest type of dog—the mongrel; and there is evidence that protrusion of the intervertebral disc occurs on the average at least two years earlier in these breeds than it does in the mongrel. Thus there is further evidence that degeneration of the disc appears to occur at an earlier age in the Dachshund, Pekingese and Spaniel than in other breeds of dog, and one can only assume that it is a definite inherited condition. It would be of great interest to know if this condition occurs more frequently in certain strains within these breeds, but unfortunately by the time symptoms develop, contact with other members of the same

litter has usually been lost. I have only met one case (in Spaniels) in which there was a history of two litter mates subsequently developing evidence of a disc lesion. This appears to be another of the abnormalities affecting dogs in which there is need for co-operation between the profession, dog breeders and the breed societies, to confirm the apparent inherent tendency to the condition and to consider the practicability of attempting to eliminate it.

"With regard to the occurrence of disc protrusions at various levels of the vertebral column the next diagram shows the number of protrusions occurring at different sites in my series (Fig. 3). It should be pointed out that this

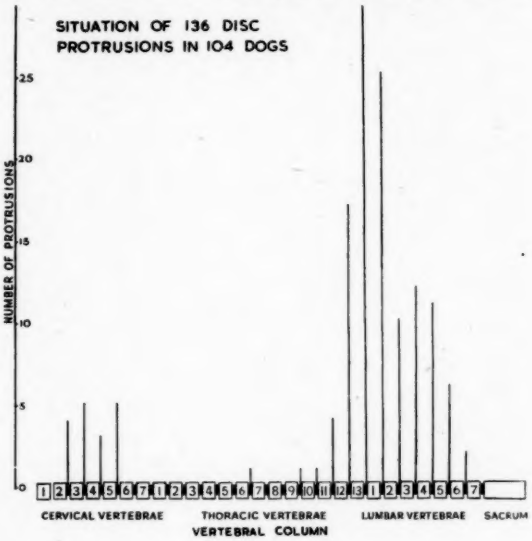

FIG. 3.

table may not include every protrusion present in that number of dogs, since only about one-third of the cases were available for *post-mortem* examination, and it is probable that in relying on radiological evidence some additional protrusions may have been missed. However, it is noteworthy that the diagram corresponds very closely with a similar one published by Hansen.

"Dr. King has discussed why the largest number of protrusions may be expected to occur at the thoraco-lumbar junction and I shall be interested to learn what further information the work on which he is engaged provides on this matter.

"One point that I have noticed relates to cervical protrusions. There were 17 dogs affected in this region in this series and the next table gives the breed incidence (Fig. 4).

BREED INCIDENCE OF CERVICAL DISC LESIONS

BREED	TOTAL NUMBER CONFIRMED CASES
COCKER SPANIEL	5
SPRINGER SPANIEL	2
DACHSHUND	5
MONGREL	3
MINATURE POODLE	2
TOTAL	17

FIG. 4.

This appears to be of interest in that, although there is the usual high proportion of Dachshunds and Spaniels, Pekingese are not implicated. This finding is supported by a paper by Olsson and Hansen recording cervical protrusions in 39 dogs of which 18 occurred in Dachshunds but only two in Pekingese.

"Since it is generally accepted that Pekingese are one of the breeds subject to disc lesions (Olsson, 1951; Hoerlein, 1953), this comparative absence of cervical lesions appears to be of significance; one wonders if it is associated with the fact that this breed has a short muscular neck which may protect the cervical discs from wear and tear to a greater degree than the somewhat longer neck of the Dachshund and Spaniel. Or is there any other anatomical factor peculiar to this breed?

"While on the subject of cervical lesions, I should like to ask Dr. King whether he can suggest any anatomical reason for the marked difference in clinical symptoms caused by cervical lesions and those occurring elsewhere. In the former case the major symptom is one of pain, with only minor locomotor involvement, while with thoracic and lumbar lesions symptoms of paraplegia usually predominate. Clinically, this is of importance, since if symptoms of comparative severity occurred in the cervical region they could interfere with respiration and terminate fatally. Some of these cases which have come to *post-mortem* examination have shown gross protrusions associated with the cervical discs, and I can only assume that there must be relatively more space around the spinal cord in the cervical neural canal than at other levels—is Dr. King able to confirm this?

"Dr. King has suggested that disc protrusions may sometimes be described as 'deadly projectiles.' This is a very apt description of those protrusions occurring in association with the syndrome described by Hoerlein as 'progressive ascending paralysis.' Here, following the usual onset of flaccid paraplegia associated with a thoracic or lumbar lesion, symptoms of paralysis spread anteriorly until the dog dies within a few days from respiratory failure. At *post-mortem* examination one finds an engorged condition of the spinal cord extending forward from the lesion sometimes as far as the anterior cervical region. This result of disc protrusion is comparatively rare (it has occurred six times in my 104 cases) but it is the one form of the condition which terminates fatally. I mention it, in the hope that Dr. King or others present may be able to offer suggestions as to its aetiology or to explain the anterior spread of symptoms.

"I have raised a few of the problems associated with this subject of disc protrusion, and I am sure that many others will be put forward by subsequent speakers, and I hope that at the end of the meeting we shall have found at least a few of the answers. Finally, I should like to thank the Organising Committee for giving me the opportunity of contributing to what will be, I am sure, a very constructive and interesting meeting."

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The General Discussion

Miss Joan O. Joshua (Finchley) offered her congratulations to the speakers, particularly the last one who had had to speak under great difficulties.* This was a subject which to the clinician was of immense importance and three excellent aspects of it had been put forward. She was fortunate in having someone† available who had done a great deal of *post-mortem* work on these cases and as a result they had learned some rather startling things.

The first point was that the practitioner could have no conception of what type of protrusion had occurred from the symptoms which arose. One case which came to mind was that of an eight- or nine-year-old Dachshund which had had difficulty in walking and had shown peculiar protruberances over the muscles of the lumbar and thigh regions.

* This was a reference to the failure of the apparatus used to project the slides.

† Mrs. D. M. Milnes, M.R.C.V.S., to whom my thanks are due.

He had responded well to a course of gold injections and for six months was walking extremely well. He then relapsed and was destroyed. At no time had it been possible to localise a lesion as on palpation it was found that the whole of the posterior spinal area was painful. At *post-mortem* it was found that six or seven discs in this dog from the mid-thoracic to the posterior lumbar region had literally exploded, exuding chalky material which must have been a continual source of irritation to the dura mater.

Then one would have another case showing complete paraplegic symptoms, where the lesions were much less dramatic, and one found perhaps only a minor protrusion which had not even ruptured the dorsal longitudinal ligament.

Six months ago she saw a Dachshund bitch with typical partial paraplegia, mainly of a spastic nature. She responded to treatment which finally included gold for a period of six weeks and ultimately was left with minor locomotor ataxia. A few weeks ago she was called to the dog with a history that she had gone off her fore legs; on examination she was found to be lame on the left fore leg and showing a recurrence of the paraplegia and it was decided to destroy her. The original lesion was detected easily, there was quite a marked protrusion and the dura mater was adherent to the area over the extruded disc—she thought, speaking from memory, that it extended between the second and third lumbar vertebrae; the cervical lesion was between the last cervical and first thoracic, the disc had literally "gone for a Burton." There was a mass of "cream cheese"-like material which resembled pus. The more one investigated these cases at *post-mortem*, the more one realised that one could not tie symptoms to lesions, although one might have a good idea of the localisation of the damage.

With regard to treatment, she had found that cases which showed spasticity and pain in a large number of cases responded remarkably well to gold. On the other hand, she had no explanation of how it worked; cases of cervical disc protrusion which, oddly enough, she had found most common in the Sealyham and, secondly, in the Cocker Spaniel, which did not respond to ordinary routine treatment within a couple of weeks, often improved within three or four weeks on a course of gold. The predominant feature of this type of case was undoubtedly intense pain.

So far as treatment was concerned, they all knew the usual routine but she had noted with interest, particularly in the slowly recovering partial paraplegic, that any nervous excitement markedly interfered with the dog's recovery. Over-anxious owners worrying about the dog could cause a relapse and removal of the dog from the owner would often result in a rapid recovery. If she found that the dog or the owner were of an anxious nature, she put the dog on to methyl-pentynol (Oblivon) as an adjunct to treatment, in some cases with spectacular results.

She was afraid her remarks were disjointed as she had not expected to speak, anyway at this early stage, but this was a subject of prime importance. She had resisted the disc theory for some time but she now felt that this lesion not only accounted for many of the paraplegias which one saw, but many of the rather odd cases of reluctance to walk, obscure back pain, recurring lumbar myositis and those odd cervical pain cases which, once one had recognised them, were unmistakable.

Dr. Richard N. Smith (Department of Veterinary Anatomy, Bristol University) said that he could only add a few remarks on the work being done in Bristol on problems of the vertebral column. In this the department was being helped by pre-clinical students who were interested enough in research work to give up their vacation time. Many of the dog cadavers which had been examined had had histories with no mention of symptoms attributable to disc prolapse; Nevertheless, protrusions of disc material had been seen in a number of these cases. Findings such as this had indicated that radiology by itself was not a satisfactory method of diagnosis. If protrusions were found in "normal" dogs then protrusions diagnosed on radiographs of affected dogs need not necessarily be those causing the symptoms.

In referring to breed incidence there was a danger that a false picture was being presented if one did not also analyse the relative frequency of the occurrence of the different breeds. For one to say, for example, that a disease was commonest in greyhounds was misleading if a large proportion of the dogs one saw were Greyhounds and this fact was not included in the analysis. Incidentally, up to about 100 greyhounds' cadavers had been examined in the department and none had shown protrusions.

Mr. L. C. Vaughan (Streatley) said that he wished to add a couple of points about the condition. The symptoms which might be met with in dogs with cervical disc protrusions varied and he wondered how many cases had been missed or mistaken for other conditions in the past. Out of 17 cases with cervical disc protrusions seven showed complete quadriplegia. He thought Mr. Douglas mentioned that most of the cases in his series had pain but it was remarkable that he should have seven out of 17 with quadriplegia. Perhaps at hospital one tended to get cases a little more out of the ordinary; they did not tend to get the dog with slight or cervical pain. One must be on the look-out for disc protrusion when one had a dog completely paralysed in the fore and hind legs. The dramatic response to disc fenestration obtained in those cases with cervical pain supported the findings of Olsson and Hansen.

The other point concerned sex incidence. It was rather interesting that sex incidence had not been mentioned but he thought the general concensus of opinion was that there was no sex disposition to the condition. He had found on a number of occasions that symptoms commenced when a bitch was in heat or was exhibiting pronounced pseudo-pregnancy. This had occurred in just over 30 per cent. of the females investigated so that it was possible that the condition was, through hormonal influence, connected with heat or pseudo-pregnancy. O'Connor in 1951 presented a paper on disc protrusion in man covering some 500 cases, and he found that 17 per cent. of the females sustained disc protrusion when they were pregnant or in labour. He suggested that the corpus luteum hormone might have something to do with the relaxation of the spinal ligament and intervertebral joints; perhaps this effect in association with the other changes which occurred in the disc might result in its protrusion.

A good deal had been said about the dynamic factor, the explosion of the nucleus pulposus through the dorsal spinal ligaments into the canal but he did not think he agreed that this was a substance which could pass with any appreciable force through such a small gap. It had been found when the spinal column was cut sagitally that the size of the rupture in the dorsal annulus and spinal ligaments was in many cases only 0.5 mm. in diameter. He could not imagine that the nucleus pulposus which, by the time of protrusion had undergone changes reducing its fluidity, would travel through an opening of that size at a fast rate.

Nothing had been said about spinal cord changes. In quite a number of cases advanced spinal cord changes had been found, particularly in the near vicinity of the protrusion.

Macroscopic changes included myelomalacia and even deliquescence of the cord. Microscopically, gross cord damage and myelin degeneration had been discovered. The futility of treatment in these cases was apparent but one could not forecast the presence of such lesions, which had been found in comparatively recent as well as in long-standing cases.

Professor G. F. Boddie (Edinburgh) said that he thought it necessary to emphasise that X-ray films must be interpreted in relation to the clinical signs. He was exceedingly loath to interpret an X-ray film of a dog's spine unless he had had an opportunity of examining the dog himself or had been given a description of the dog's clinical signs on which he could rely.

In regard to breed incidence, it must be remembered that certain breeds tended to be fashionable. He did not think enough information was available to say much about breed incidence. It did seem to be established that the incidence was higher in the short-legged long-backed breeds. A fair proportion of cases responded to conservative treatment. One of the greatest problems for the clinician was to decide when to continue with conservative treatment.

Mr. T. C. Denholm (Carlton) complimented Dr. King and the two openers on their excellent contributions to what had been to him, at any rate, a very difficult problem for a number of years. Quite honestly, he did not know when a dog had a slipped disc and when it had not. He X-rayed normal dogs and found they had slipped discs and X-rayed those with paraplegia and found that they had not and for

that reason he was interested in Dr. Smith's remarks about the number of discs he found slipped on *post-mortem* examination.

In his practice the majority of cases of paraplegia occurred not in active dogs as he understood the term, but in dogs which were capable of rapid action. He might seem to be splitting hairs but, to him, a Greyhound was an active dog, and a Dachshund was not, when it got to five, six or seven years of age. The majority of them were fat and lazy unless they saw a cat or a rat; they were capable then of 10 or 20 yards fast movement and it was these dogs that the owners found unable to walk in the morning. The Dachshund was the one which caused him trouble, although he had seen the condition in Spaniels, Sealyhams and Pekingese.

Dr. Brook mentioned the extreme pain which occurred in the first two or three days; it really was extreme pain, the dog screamed before it was touched, and it was his custom to administer a sedative for two or three days and apart from that to leave the dog alone. They were in enough pain and it was cruel to move them. After two or three days the pain disappeared.

He thought it was Mr. Vaughan who referred to this condition in bitches. He found many Dachshund bitches in middle life who seemed to fit the picture. The owner found them paralysed in the morning and on inquiry into the history one nearly always found that they had been on heat recently or were in a state of pseudo-pregnancy. This puzzled him and he thought perhaps a hormone would answer. He treated one or two with testosterone and to his surprise they got better very rapidly, so much so that he carried on with it. If he got a fat bitch which fitted this picture, after the initial pain had gone he started injecting minute doses of testosterone daily and the response was really remarkable. He could not explain it; he was not a pathologist, he just knew that it happened, but he would like some information from the platform on this subject.

Gold injections* and infra-red radiation were also helpful. Miss Joshua said that she had found that if there was any nervous tension in the house the patient seemed to regress rather than progress. He remembered the case of a little Dachshund which was completely paralysed in the hind quarters. The owners went out to work and the house was looked after by the wife's mother who was in her 80's and not as even tempered as she used to be. Every time he went to see the dog, unless he went at night when the owner was at home, the old lady did her utmost to persuade him that the dog should be destroyed, she was sick of it. He considered that her attitude towards the dog was making it worse and he took it to the surgery and kept it there for a day or two and there was a noticeable improvement in 24 hours. He thought that nervous tension, whether of the type he had outlined, or nervous tension due to the owner wondering whether the dog should be destroyed or whether treatment should be carried on for another week, certainly seemed to have some effect on the condition.

Mr. F. G. Waddington (Watton) said that he thought this problem of disc protrusion should be considered in terms of the "triangle of forces," and the immediate causes of protrusion were largely a matter of applied mechanics. He suggested that the disc was maintained in position between the vertebral bodies by a state of equilibrium between the tension in the spinal ligaments and the tone of the lumbar region muscles. If at any time the articular surfaces of the vertebral bodies were not parallel—as was the case if the spine was in a state of curvature—and there was a disturbance of the equilibrium between muscles and ligaments, protrusion of a disc was likely to occur. He was of the opinion that a disc did not protrude during a sudden muscular effort but immediately after the effort had been made. If one imagined a man stooping down to lift a heavy weight, his lumbar muscles would be tensed, the dorsal aspect of the gap between vertebral bodies was widened and the longitudinal dorsal ligament would be stretched. At the completion of the effort, which might be sudden, the muscles would relax and possibly the dorsal longitudinal ligament might be slow in contracting again and conditions would be favourable for disc protrusion at that moment. It seemed likely that in dogs sudden disturbances of the equilibrium between muscles and ligaments could occur in sudden twisting movements, as when a dog jumped awkwardly on or off something, or jumped and twisted in the air, as occurs when a dog jumps up to greet its owner or to grab at its lead prior to being taken for a walk.

He was interested in the statistics of the incidence of disc protrusion in different breeds and the frequency of protrusions in different regions of the spine. He noticed that cervical disc protrusions seldom occurred in the Pekingese, and suggested that if the use of dog collars was abandoned there would seldom be any cervical protrusions in other breeds. Imagine a dog which does not walk well on a lead, which has been kept in all day and is then taken for a walk; it is full of excitement, strains at the lead and often scrambles along with head low in its effort to get along. In this state the dog's ventral neck muscles are tensed against the collar, the dorsal aspect of the gap between the bodies of the cervical vertebrae is widened and the dorsal neck muscles are somewhat relaxed. Thus, conditions are produced which would favour dorsal protrusion of a cervical disc. Now, it is common knowledge that most Pekingese never wear dog collars, most owners preferring the chest braces in this breed and it is suggested that this is why cervical protrusions do not occur in this breed.

He noticed with regard to treatment, that no mention had been made of spinal traction as a means of restoring a disc to its proper position; he said this was one of the treatments most commonly used with success in the human subject. He had used this method on a number of dogs, and with the help of an assistant had put powerful longitudinal traction on the spine, with and without an anaesthetic. He had had a number of quick recoveries, one immediate, after this form of treatment.

He thought that an anaesthetic was to be preferred on humane grounds and to obtain muscular relaxation if this treatment was applied.

He was of the opinion that it was possible to obtain some idea as to which disc was displaced when examining a dog, without the help of X-rays. Percussion along the supraspinal processes would often produce marked pain when the region of the disc protrusion was percussed.

He noticed that Greyhounds and Foxhounds rarely sustained slipped discs, and he was of the opinion that these dogs were generally kept in first-class condition; the tone in their back muscles was well maintained and an upset in equilibrium between muscles and ligaments was not likely to occur easily. In fact, all working dogs kept in hard condition seldom showed disc protrusion. Such dogs, too, were seldom seen straining at a lead and possibly they were in the same category as Pekingese as regards cervical disc protrusions. He would like to hear someone else's view on the likelihood of straining at a collar being a cause of cervical disc protrusion.

Dr. Brook said that he had omitted to say something about *post-mortem* technique. If one attempted to pin a dead spine the result was chaotic. The nervous tissue was floppy and semi-fluid. He used the same procedure as for sheep; the spine was isolated, fastened to the table, and a needle was put into the sternum magna and through the lumbar sacral space. It was left untouched for five days, when the whole thing was then as solid as one could wish.

Mr. J. M. Ingram (Oxted) said that this was a very perplexing subject and one with which the practitioner was confronted more and more. It was difficult to get down to hard and fast figures as far as breed incidence was concerned because the breeds varied from district to district. He had done a fair bit of X-ray work on these cases which in the early stages were not very satisfactory. He had tried some of the contrast media but a tragic result had eased him off using them. As usual, one had learned a great deal not only from the paper but from the discussion, and he was sorry he could not add a great deal to it. It was wonderful what patience could do in these cases and Miss Joshua's remark with regard to the psychological approach to the owner as well as to the dog applied equally well to many other conditions.

He would like to thank Dr. King very much for his most excellent paper and especially for the informative drawings and sketches which were most helpful.

* Myocrisin—May & Baker.

Miss Olga Uvarov (Cobham) wished to add her quota of thanks to Dr. King and the other speakers; to Dr. King, not so much for describing the actual anatomy of disc protrusion, but also for pointing out certain clinical findings, such as the importance of possible subclinical cases of disc protrusion, the ageing of the disc—that was a very important observation which she had never seen in print before—and even the psychological approach to dogs unable to report their various symptoms. In this paper there was a combination of anatomical and clinical information.

She would also add her quota of confusion to the question of breed incidence. In her experience Dachshunds had the highest incidence, Pekingese were next, Cocker Spaniels were third and Sealyhams fourth. She thought, speaking from memory, that during the course of something like 19 years of practice she had seen two cases of paraplegia which one would now presume on clinical grounds to be disc protrusions (it was not always possible to carry out X-ray diagnosis). One case had occurred in a Collie and the other in a Dalmatian.

The other point was that if an animal did not recover within three or four weeks, and illness became protracted to nine weeks or longer—then most of these cases were incurable. If the condition recurred, perhaps within a year, then in her experience most of these cases were hopeless and had to be destroyed. She did not think that exercise could be blamed as one of the causes, she would agree with Mr. Waddington and others that it was not found in working dogs such as Greyhounds. Greyhounds raced during the time when protrusions were found in other species.

As to treatment, she thought most practitioners had tried everything, including heat therapy. She would agree with all that Miss Joshua had said with regard to owners. The latest tendency was to use vitamin B_{12} and there were one or two reports from America on the use of cortisone—the results so far were not conclusive.

She would sympathise with Professor Boddie from the point of view of personal experience and the mistake of having merely a radiological symptom. A few years ago she herself was diagnosed as having one of these discs; it was depressing to have it and to be told that it was in fact due to senility of one disc. All sorts of treatment were tried without success, and eventually three weeks' holiday in the sun cured all symptoms. It was extremely interesting to know to what extent these subclinical cases were of importance.

She had one embarrassing case in a cross-bred Terrier where a diagnosis of disc protrusion was made, an X-ray was taken, and the consultant gave the owner a week in which to make up her mind whether surgical interference should be carried out. Fortunately, the dog vomited round worms within a few days of X-ray diagnosis and was perfectly normal within a week. That was the type of case which made one think of the importance of subclinical disc protrusion in relation to other findings.

Miss Joshua wondered if Dr. King could say what he considered to be the normal spinal curvature of the dog and what part he thought so-called roach back played in these cases. In some breeds, such as the Dachshund and Pekingese, this was important. She thought the question of slow, ascending paralysis was important; her own interpretation was that the lesion was reasonably far forward, probably within the last few thoracic vertebrae causing the fluids to gravitate forwards causing pressure on the anterior spinal nerves.

The Reply

Dr. King, in reply, said that he was very interested in the question of the working dogs. As Dr. Smith had said, at Bristol they were coming to the conclusion that racing Greyhounds were immune from this trouble, which was perhaps rather rash. However, one or two people in the hall had had great experiece of Greyhounds and they had agreed that this was so. He had never come across a case of either clinical disc protrusion or even of protrusion found on *post-mortem* in a greyhound. Exactly the same point was made by Dr. Brook about the working Collies. He thought it was physically the same factor at work, namely, that the dogs were in the pink of condition and did not subject themselves to the sudden uncontrolled contortions which the animal not in training was apt to experience.

The point made by Mr. Waddington was perfectly right. If a parallel could be drawn from man, the serious cases were those where the man at the other end dropped the weight, it was the unexpected strain that was dangerous. One could imagine that the lap dog or domesticated dog would occasionally find itself doing something unexpectedly energetic, and that was the sort of thing which would precipitate a dangerous protrusion.

The age incidence of clinical cases, given by Mr. Douglas and Dr. Brook, was very interesting. He was comforted by their findings, because they had a big incidence at five to seven years of age, whereas the report by Hoerlein indicated that the big incidence was between two and four years of age. Since the process of degeneration was becoming advanced only at about five years, one would expect a great increase of incidence from about that age and not as early as Hoerlein's findings suggested.

The sex factor which was mentioned by two speakers was baffling. It could be that in pregnancy it was simply a matter of weight, the strain on the thoraco-lumbar junction being greatest when the abdomen was carrying the foetus. As for oestrus he thought a point made by Miss Joshua might bear on that. She had suggested in an article in THE VETERINARY RECORD that highly temperamental animals were more susceptible to nervous disorders and if there was any tendency to nervous symptoms it was exaggerated by hysteria. Perhaps the dog in oestrus was more easily emotionally disturbed.

Mr. Douglas mentioned severe accidents, such as being run over by a motor car, and there was one point which was quite interesting. He thought everyone was agreed that it was generally the vertebrae which broke and not the disc. In Bristol, experiments had been carried out submitting the disc and the adjoining bone to various types of mechanical strain. They had tried shearing bones one from the other with the disc in between, and they had tried increasing the weight on one vertebra and forcing it down until something snapped. It had surprised them to discover that the disc snapped just as often as the vertebra. Conditions experimentally were not the same as in life, of course, but the disc might be more vulnerable in severe accidents than one thought.

He was glad to hear Professor Boddie, Dr. Smith and Mr. Denholm agree that the approach to diagnosis through the X-ray was disappointing. He thought there were many reasons why that was so. One point from the anatomical aspect was that the Swedes had suggested that if a disc was seen to be narrower than its neighbours in an X-ray taken from the dorsal view it indicated a disc which had exploded. At Bristol a number of spines had been measured accurately and it had been found that there were quite normal variations in the thickness of the disc without any presence of protrusion, so that relative narrowness was not a satisfactory criterion for protrusion.

The question of the dynamic factor had been mentioned. He disagreed with Mr. Vaughan, and was in fact impressed and convinced by Olsson's dynamic factor. Olsson explained that it was fluctuation in the size of the protrusion which was pathogenic. He had said that protrusions sometimes "exploded" right out, but he was also trying to explain that the extraordinary changeability of symptoms was due to the oscillation in and out of the protrusion. A point like this was made by Miss Joshua when she said how strange it was that large protrusions did not cause symptoms and quite small ones did. He thought this was so, and that was because protrusions tended to ride in and out again.

One last point, the question of roach-back which Miss Joshua had mentioned. In man if the disc protruded the general rule was that some degree of exaggerated curvature developed as a result. Yet Hansen said that this rarely occurred in dogs, and that when protrusion occurred the curvature of the spine remained normal. The only other statement he had seen on that subject was in a report of some experimental work where they were able to produce kyphosis in the dog in the thoraco-lumbar region by experi-

mentally causing protrusion. However, he himself had seen dogs pottering about with roach-backs which also showed signs of chronic disc protrusion.

He would like to thank the other two speakers and everyone else for dealing so kindly with him in his extremely exposed position. Anyone who, from a specialised standpoint, intruded into the centre of a field where many specialists had convergent interests was liable to be shot at from all sides. He would also like to say that he thought it was a great honour that anatomy had been asked to come forward and make a contribution at this Congress. He thought the pre-clinical workers had recently stood back too much from the clinicians, so that the anatomist and physiologist had tended to become isolated. He hoped this paper to-day would mark the beginning of a drawing together of the pre-clinical and clinical subjects.

The Chairman (Mr. J. S. Steward) congratulated Dr. King on his admirable paper and the openers on their contributions. There had been an excellent discussion.

The Practical Application of Artificial Insemination in Pig Breeding

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Introduction

OF all the domestic animals, the pig is the most suitable for live-stock improvement through the widespread use of artificial insemination. It is a rapidly reproducing animal, extremely prolific and very early maturing. Consequently, if the right sires can be found and a satisfactory technique for insemination developed, the potentialities of artificial insemination in this species are enormous. In fact, it is not beyond the bounds of possibility, even with the present techniques, for a boar to sire about 20,000 offspring in a single year, and no doubt as research continues this figure will be greatly increased. It is essential, therefore, with such a powerful weapon for either good or ill, to be quite certain that the boars used are of a suitable standard, and it is inevitable that eventually the artificial insemination organisation will have to be very closely linked to the National Progeny Testing Stations which are being established at the present time.

To a veterinary congress of this nature, the potentialities of artificial insemination as a means of controlling certain diseases in pigs may also be of special interest. An example which comes to mind most readily is the fact that many farmers to-day are considering the possibility of eradicating virus pneumonia by the establishment of disease-free herds. This is a big step and it is complicated by the fact that there are relatively few herds from which new breeding stock can be introduced. The problem would be eased quite considerably if semen from any boar could be used on the disease-free breeding sows, and this could be achieved quite simply by means of artificial insemination. It seems likely, therefore, that there will be a demand to develop artificial insemination on a relatively small scale for use privately in pedigree herds as well as a demand to develop it on a large commercial scale. Practitioners who are called in to advise on techniques of artificial insemination in private herds will not be faced with all the problems besetting those who are concerned with the establishment of a large scale service. It will not be necessary, for instance, to dilute the semen to the largest possible extent in order to obtain the maximum number of insemination doses from one ejaculate; neither will it be necessary to store the semen for any length of time and, perhaps most important, the pigs to be inseminated will be under close supervision and the exact time of their oestrous cycles can be determined.

The present communication is concerned primarily with problems connected with the wider use of artificial insemination on a commercial scale, and under these conditions it is necessary to use high dilutions for the semen, store it for several days and inseminate pigs on a large number of small farms where supervision is often rather inadequate. The difficulties encountered, however, will probably also be of interest to those intending to use A.I. in private herds.

In view of the obvious possibilities of improvement by means of artificial insemination, it is rather surprising that more work has not been carried out on the development of suitable insemination techniques in the pig. Some early work was done in Russia (Milovanov, 1932; Rodin & Lipatov, 1935) and although this appeared promising it was of an experimental nature only and no effort was made to put the techniques to practical use in livestock improvement. More recently some interesting experiments were carried out in Japan which clearly indicated that insemination in pigs might be a practical proposition (Ito, Niwa, Kudo & Mizuho, 1948). It was not until some two years ago, however, that the possibility of making use of the techniques for livestock improvement was seriously considered in this country and an attempt made to develop a satisfactory technique for application in the field (Polge, 1956a).

Natural Service

When considering methods for artificial insemination in pigs, it is useful first of all to take account of what appears to happen under conditions of natural service. Unlike the bull which delivers a relatively small volume of concentrated semen into the upper part of the vagina or cervix of the cow, the boar delivers a very large volume of semen (100 to 500 ml.) directly into the uterus of the sow. Some information on the mechanics of this performance was obtained by removing the reproductive tract from a sow which was on heat and allowing the boar to serve into this excised reproductive tract which was held inside an artificial vagina. The cervical canal is very long and tapering (Fig. 1), and its internal structure presents distinct ridges against which the corkscrew-shaped end of the boar's penis can grip. During the act of penetration the distal part of the penis rotates and engages these ridges either forming a seal to the posterior portion of the cervix or resulting in its complete penetration. It

seems likely that in gilts where the anterior part of the cervix is generally very constricted the penis may be held only within the cervical canal, but in the case of sows which have had young it probably directly enters the uterus itself. In either case, there appears to be an effective mechanism to prevent the backflow of a large quantity of the semen. Once ejaculation commences, the thrusting action of the boar's hindquarters ceases and the animal stands quite quietly while the semen is being forced directly into the uterus. During the course of ejaculation, but particularly towards the end, considerable quantities of gel are produced and it is believed that this gel acts as a plug preventing the escape of semen via the cervix and vagina.

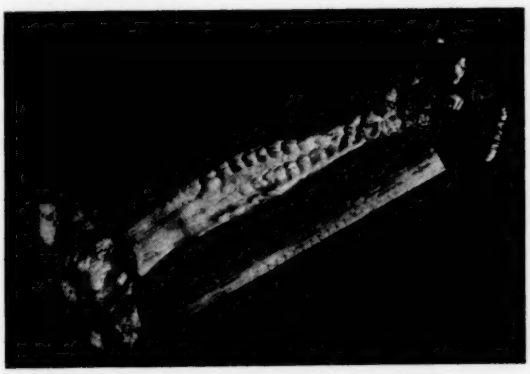

FIG. 1.—Part of the reproductive tract of a sow dissected to show the internal structure of the vagina and cervix.

A.I. Techniques

One of the problems of artificial insemination is to determine whether or not a large volume of semen penetrating the uterus is necessary to produce normal fertilisation. If large volumes of semen are used, it is important to ensure that the cervix is sealed while the semen is injected otherwise much of it would be lost in the vagina and expelled later on. Loss of semen in this way could be prevented either by completely penetrating the cervical canal which requires a relatively fine plastic tube, or else by using a compressible rubber tube which acts as a plug to the posterior portion of the cervix. Another possibility is to use an inflatable cuff close to the tip of the inseminating catheter. All these methods have been tried and it was found that it was possible to penetrate the cervix of most sows with a plastic catheter 6 mm. in diameter, but that with gilts a much finer catheter was necessary, not more than 4 mm. in diameter. Even with such a fine catheter, however, it was not always possible to penetrate the cervix of some gilts. In addition it was noticed that the probing of a catheter in the upper region of the cervical canal sometimes caused bleeding and in practice a rubber or cuffed catheter may be more practical.

Results from Artificial Insemination under Laboratory Conditions

The methods of collecting semen and insemination employed in the early experiments have been described in detail by Polge (1956a) and will be illustrated in a film at this Congress and it is not proposed to discuss these during the course of this paper.

It is sufficient to say that 100 ml. of diluted semen was used for gilts and 200 ml. for sows. A pregnancy rate of between 50 and 60 per cent. was obtained when antibiotics were added to the diluting fluid and the semen was used on the day of collection (Table I).

TABLE I

LABORATORY EXPERIMENTS
INSEMINATIONS WITH SEMEN STORED TWO TO SIX HOURS

	Number of sows and gilts inseminated	Number pregnant	Per cent. pregnant	Average litter size
With antibiotics in diluent) ...	65	39	60	11
(Without antibiotics in diluent)	64	29	45	10

However, there was a considerable reduction in the pregnancy rate when the semen which was stored in a refrigerator at 5° C. was used on the day following collection (Table II). In the majority of cases the females on which these figures were obtained were tested for oestrus by the use of a vasectomised boar and were inseminated on the second day of heat. The number of sperm injected varied from 2 to 15 x 10^9 and the diluting medium was 2 per cent. glycine in distilled water with 30 per cent. egg yolk.

TABLE II

LABORATORY EXPERIMENTS
INSEMINATIONS WITH SEMEN STORED 24 TO 30 HOURS

	Number of sows and gilts inseminated	Number pregnant	Per cent. pregnant	Average litter size
(With antibiotics in diluent) ...	26	9	35	9
(Without antibiotics in diluent)	35	9	26	6

Field Trials

The application of experimental techniques in the field commenced with the setting up of an artificial insemination service for pigs at the cattle breeding centres of Dartington Hall, Cambridge and Hampshire. The schemes were dovetailed into the normal A.I. routine for cattle, the same inseminators carrying out both types of services. At the Cambridge centre, the semen was diluted with the yolk/glycine medium (as above) to the extent of 1:4 to 1:9 and used largely on the day of collection. Doses of 100 ml. were used for both gilts and sows.

The method of calculating the conception rate in cattle A.I. is to express it as the percentage of animals which have not been notified as having returned to the first service after three months. The same method was applied to pigs in the initial stages, but as data became available on farrowing it was obvious that such a method had very little value. The three-month figures bore little relation to the

farrowing figures. This discrepancy is no doubt due to the fact that many pigs, if they do not become pregnant to one service, are disposed of to the bacon factory, and the A.I. centre is not notified until farrowing data is collected. It will be necessary, therefore, to replace " conception rate " by the actual percentage of pigs inseminated for the first time which farrow. No other method is considered to be of sufficient accuracy to be of any value in comparing results.

The results from the first 10 months of work at the Cambridge centre are shown in Tables III and IV. Although it has not been possible to collect the complete data on farrowing in time to present here, it is clear that the results from the field are considerably lower than those obtained under laboratory conditions.

Five months after the scheme had started, gel from boar semen and antibiotics (500 units of penicillin and 500 units of streptomycin per ml.) were introduced into the semen diluent. Normally during the preparation of semen for insemination, the gel fraction is removed and discarded because it makes the semen very difficult to handle. The importance of the gel fraction, however, is not known and it is certain that in natural mating considerable quantities of gel enter the uterus as well as forming a plug in the cervix (Mann, Polge & Rowson, 1956). For these experiments the gel which was removed from the semen was freeze-dried and later incorporated into the diluting medium at a concentration of 0.25 per cent. At this concentration a fairly homogeneous mixture could be obtained which was not excessively viscous. Higher concentrations were difficult to handle and the equipment was very liable to become blocked. The farrowing rate was increased when gel and antibiotics were included in the diluent, but it is possible that this effect was due entirely to the antibiotics as was shown in the laboratory experiments. The laboratory experiments showed that gel was not essential to fertilisation or pregnancy and an experiment now in progress which separates the effect of gel from that of antibiotics appears to indicate that the presence of gel in the diluent does not materially affect the farrowing rate.

One of the principal reasons for the lower results from the field experiments as compared with the laboratory experiments seemed to be the difficulty in the field of correctly timing the insemination. It was obvious that many farmers found it hard to decide whether or not their sow or gilt was in oestrus, particularly where only one or two animals were kept. Many animals which would not stand for artificial insemination had to be rejected by the inseminators and it is believed that in the field application of the technique, this question of detecting oestrus and the timing of the insemination is going to be a major problem. In the majority of cases, the sow ovulates about 36 to 40 hours after the onset of oestrus. It

TABLE III

FIELD TRIALS

CONCEPTION RATE AND FARROWING RATE FROM ARTIFICIAL INSEMINATION IN GILTS AND SOWS

(Semen used on day of collection)

Month	Number of first inseminations	Conception rate figures at three months (per cent.)	Number farrowed	Results not yet obtained	Farrowing rate (per cent.) *		Average litter size
					Maximum	Minimum	
		(No antibiotics or gel in diluent)					
1955 May	17	65	4	0	24	24	10·0
June	21	67	5	2	33	24	9·0
July	26	65	6	5	42	23	8·4
Aug.	33	55	3	7	30	9	5·0
Sept.	32	52	10	2	38	31	8·5
	129	60	28	16	34	22	8·7
		(Antibiotics and gel added to diluent)					
Oct.	41	68	18	3	51	44	10·0
Nov.	62	63	19	3	35	31	10·2
Dec.	45	80	15	6	47	33	8·7
1956 Jan.	48	56	12	8	42	25	7·6
Feb.	24	63	7	5	50	29	11·0
	220	66	71	25	44	32	9·4

* Because the full results have not yet been obtained, the farrowing rate has been expressed as two possible figures, the maximum assuming that all the missing results would be positive and the minimum assuming that they would be negative.

TABLE IV

FIELD TRIALS

CONCEPTION RATE AND FARROWING RATE FROM ARTIFICIAL INSEMINATION IN GILTS AND SOWS

(Semen used one and two days after collection)

Number of first inseminations	Conception rate figure at three months (per cent.)	Number farrowed	Results not yet obtained	Farrowing rate (per cent.)		Average litter size
				Maximum	Minimum	
69	41	15	3	26	22	10·6

is important to determine when oestrus commences and to carry out the insemination on the second day some 6 to 12 hours before the expected time of ovulation. The ability of owners to detect the beginning of oestrus would appear to vary greatly, and our results indicate that in the bigger herds with experienced pigmen, farrowing results following inseminations are better than in the herds of five pigs or less (Table V). It is believed that this is largely due to the experienced pigmen being able to detect the onset of oestrus with more certainty and consequently to have the sows inseminated at the correct time.

TABLE V

RESULTS OF ARTIFICIAL INSEMINATION IN HERDS OF DIFFERENT SIZES

Herd size							
Less than 5 pigs		5 to 10 pigs		11 to 15 pigs		More than 15 pigs	
Number of pigs inseminated	Per cent. farrowing	Number of pigs inseminated	Per cent. farrowing	Number of pigs inseminated	Per cent. farrowing	Number of pigs inseminated	Per cent. farrowing
245	28·2	26	34·6	19	46·3	40	65

A further indication of the importance of timing is shown by the fact that if the pigs do become pregnant, the litter size is generally quite satisfactory and the percentage of litters below five is quite small (Table VI).

TABLE VI

DISTRIBUTION OF LITTER SIZE

(Based on 126 litters)

Less than 5 pigs in litter	5 to 10 pigs in litter	11 to 15 pigs in litter	More than 15 pigs in litter
12·7 per cent.	42·1 per cent.	39·7 per cent.	5·5 per cent.

It is difficult to see how the question of overcoming the problem of the detection of oestrus can be dealt with other than by the use of a vasectomised boar which would not be economic or possible for the small pig keeper. It is generally easier to detect the onset of heat in the first week following weaning and it is possible that as experience is gained, owners will become more familiar with the early symptoms of oestrus in gilts and the results of artificial insemination will improve proportionately.

Discussion

As was to be expected, the introduction of artificial insemination in pigs on a field basis has presented a number of problems, some of which are of a technical nature and should be overcome without too much difficulty, but others concerned with management and experience in handling pigs may be more difficult.

The ease with which semen can be collected from the boar by means of a dummy sow and artificial vagina makes the management of pigs at an artificial insemination centre a relatively simple proposition. The boar is also a very prolific producer of semen since regular collections of semen can be carried out every other day for long periods of time. The faculty of the boar for maintaining sustained services has proved most useful at the present time when semen is not being used for more than one day following collection since it has not delayed the establishment of the experimental artificial insemination services.

The dilution and storage of semen still presents a problem. It is certain that we have not yet found the ideal diluting fluid and research on this subject is continuing in the laboratory. One difficulty that has been encountered is that the motility of the sperm is not a very reliable guide to its fertilising capacity. Semen diluted in the yolk-glycine medium, for instance, maintains a high degree of activity during storage for at least three days, but the fertilising capacity falls off much more rapidly. Similar observations have been made with the semen of some other species, especially ram semen (Dauzier, 1956) and fowl semen (Polge, 1950). In both these species, however, it was found that diluents containing milk proved more satisfactory for the maintenance of fertilising capacity than those containing egg yolk. Mesnil du Buisson & Dauzier (1956) have recently reported the recovery of fertilised eggs from pigs following insemination with boar semen stored for 48 hours in a diluent containing milk, glucose and sodium bicarbonate. In addition, Ito *et al.* (1948) obtained a relatively high pregnancy rate (62.5 per cent.) from boar semen which was kept for 24 to 48 hours without the addition of any diluting fluid. Undiluted semen, however, must be stored at a higher temperature than diluted semen (around 15° C.) and it is possible that further work should be carried out on the optimal temperature for preservation. The fact that quite a number of pregnancies have already been obtained with semen stored for several days is very encouraging and would indicate that the preservation of the semen should not prove an insurmountable problem.

Some experiments have been carried out on freezing boar semen, but so far no pregnancies have been obtained. The proportion of boar sperm surviving freezing has been rather smaller than that in bull semen and an added difficulty is that concentrations of glycerol in excess of about 5 per cent. tend to reduce fertility even without freezing (Polge, 1956a).

Many variations may be introduced into the technique of insemination. It is certain, however, that any method used should ensure the minimum wastage of semen. Another point which may be of interest in the technique of insemination is the possible importance of stimulating the cervix. In the cow it has been found that stimulation of the cervix at the time of insemination increases the degree of uterine activity, probably through the release of oxytocin (Hays & VanDemark, 1953). Active contractions of the uterus may play a large part in assisting the transport of sperm to the site of fertilisation

and it is possible that this would be especially important in the case of the pig where insemination normally takes place directly into the uterus. It might be advisable, therefore, when carrying out insemination in the pig, to stimulate the cervix with the catheter in much the same way as must be done by the thrusting motions of the boar's penis before ejaculation takes place. It has also been shown that adrenaline will counteract the effect of oxytocin and reduce uterine activity. Care should be taken, therefore, to ensure that the pigs to be inseminated are not excessively frightened and it would not seem advisable to try to restrain them in any way.

So far as the quantity of the insemination dose is concerned, relatively large volumes have been used in order to simulate the normal ejaculate from the boar. In a small experiment, there appeared to be no difference in the percentage of gilts which became pregnant when either 100 or 200 ml. of diluted semen was used. In sows, on the other hand, the pregnancy rate was reduced with 100 ml. of diluted semen as compared with 200 ml. (Polge, 1956b). Mesnil du Buisson & Dauzier (1956) found that there was no difference in the proportion of eggs fertilised when pigs were killed and examined three days following insemination with either 50 or 250 ml. of diluted semen. The proportion of pigs pregnant at one month, however, was much higher in the group receiving 250 ml. and they suggest that the large volume may influence pregnancy in some way. By contrast, other workers have reported successful results following insemination with only 50 ml. (Ito *et al.*, 1948; Wiggins, Grummer & Casida, 1951) and it would appear that the importance of volume should be further investigated.

The greatest practical difficulty, as has already been stressed, is the correct timing of insemination in relation to the time of oestrus. Since ovulation occurs in the middle of heat, pigs will accept service for some time after ovulation when the likelihood of fertilisation is very small. It is very easy, therefore, to inseminate pigs too late in heat. Results from natural service suggest that the conception rate is similar when mating takes place on the first or second day of heat (Burger, 1952) and it would seem better to be too early than too late with the insemination. The incorrect timing of insemination has been considered by some people to be responsible for pigs failing to return on heat even though they are not pregnant (Mesnil du Buisson & Dauzier, 1956) and the possibility of causing uterine infection by inseminating outside the heat period, as has been shown in cattle (Rowson, Lamming & Fry, 1953) should not be overlooked. It is unfortunate that the greatest demand for artificial insemination will undoubtedly come from the small pig keepers where the management is often bad and the correct diagnosis of heat is most difficult.

In conclusion, it can be said that there seems no doubt at all that given suitable conditions where the oestrus times are known with reasonable accuracy, quite satisfactory results can be obtained with artificial insemination even at this early stage. Improvements in technique should lead to results approaching those obtained with natural mating and it is believed that with more experience the management factor will also be solved.

The technique is not yet ready for an extremely rapid expansion on a national basis, but field trials should be encouraged because it is only through the experience gained in these that future progress can be made.

Summary

The use of artificial insemination as a means for live-stock improvement and for the control of certain diseases in pigs is described, and the results of recent laboratory and field experiments are discussed in relation to the possibility of establishing an artificial insemination service.

Semen can be collected from the boar at regular intervals every other day with the aid of a dummy sow and artificial vagina, and the addition of suitable diluting fluids to the semen, containing egg yolk, permits the preservation of sperm motility for three to four days.

The physiological basis for artificial insemination is examined and the necessity is stressed for ensuring that the relatively large volume of semen injected enters directly into the uterus.

Under laboratory conditions, when pigs are tested with a vasectomised boar and inseminated on the second day of oestrus, the insemination of 100 to 200 ml. of diluted semen, used on the day of collection, leads to a pregnancy rate of between 50 and 60 per cent. The results are improved when antibiotics are added to the semen diluent, but they are reduced if the semen is stored for more than one day.

By contrast, using similar techniques under field conditions, the pregnancy rate so far recorded is only between 30 and 40 per cent. The worst results are on small farms where the supervision of pigs is often inadequate, and it is suggested that the discrepancy between laboratory and field experiments can be explained largely by the difficulty which is encountered in detecting oestrus and carrying out inseminations at the correct time on small farms where no boar is kept.

The average litter size from all animals inseminated is normal.

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THE SPEAKER'S INTRODUCTION

The Chairman, Mr. W. P. Stokes, called upon Dr. Polge to introduce the paper.

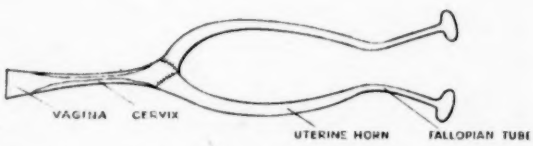
Dr. C. Polge: "About two minutes ago when I had arrived with a prepared lecture I was told that you all had had the paper previously circulated to you and that it would be taken as read. All I was required to do this morning was to introduce the subject generally. So I shall do just that and touch on what we consider to be the major or most interesting points in this problem of the practical application of artificial insemination to the pig breeding industry.

"All of us here are aware of the rapid growth in the practice of artificial insemination in cattle and of what value this has in the field of live-stock improvement. I think on the question of artificial insemination in pigs we should keep in the forefront of our minds all the time the important point of live-stock improvement in this species, because, as we have pointed out in our paper, the pig is probably the most suited of our domestic animals for improvement by means of artificial insemination.

"If we consider that improvements in cattle can come about only by raising progeny tested bulls, and that it takes five or six years to obtain a progeny test on a bull, and we compare this with the fact that in a boar one might be able to obtain a progeny test in 18 months or so, we can see that valuable breeding boars can be put into widespread use very quickly. Also, if the techniques for artificial insemination continue to develop well, we should be able to produce large numbers of animals from single boars. The figure we have quoted—20,000 offspring in one year—represents about 1 per cent. of the total pig breeding population in this country. That figure gives an idea of the influence artificial insemination could have on pig breeding.

"Also, it will be very useful in private herds for the control of diseases such as virus pneumonia. We must bear in mind the possibility that we may spread diseases by artificial insemination, and take the appropriate precautions.

"When considering the technique of artificial insemination I think it would help us if we just glance quickly at the physiological basis for A.I. and consider what happens under conditions of natural mating. We have shown in our paper a picture of a reproductive tract of a sow on page 4. You can see the long, tortuous cervix leading into the uterus. The anterior portion of the cervix is very constricted and when studying the penetration of the boar's penis into the cervix we found that during service the corkscrew-shaped penis engaged with the rather ridged interior surface of the cervix and penetrated to such an extent that it prevented any backflow of the large quantity of semen that is normally inseminated. Further than this, we have studied what happens to the semen after service. A rough diagram of the reproductive tract of a sow is as follows:



"Immediately after service the uterine horns are full of semen, but if pigs are examined about two hours after mating we find that the large volume of semen has almost vanished. Workers have studied the survival of the sperm after mating in various portions of the reproductive tract. If semen is left at the bottom of the cervix the sperm die very quickly, in the course of a few hours, and they do not live very long in the horns of the uterus itself, perhaps 10 or 15 hours; but at the junction of the fallopian tubes with the uterus there is a region where the sperm seem to survive for a longer time than elsewhere.

"When we consider what we should aim for in artificial insemination it seems that we must ensure that the sperm pass up to the utero-tubal junction where they are in a position to penetrate the tubes and cause normal fertilisation. For this we must ensure that the semen is inseminated directly into the uterus with as little wastage as possible so that it gets the chance of reaching this point. If a lot of semen is left in the cervix or round the vagina, even if it is not expelled, the sperm are likely to die very quickly in that region. On this basis therefore we have used various types of catheter for injecting the sperm to try to get it into the uterus.

"First of all we used a rather thick rubber catheter which could be forced up into the cervix. This did not penetrate right into the uterus, but the effect of the compressed rubber helps to prevent the semen from flowing back into the vagina. We have also tried actually to penetrate the top part of the cervix and inseminate directly into the uterus with various types of plastic catheter. A very thin plastic catheter will get through the fine cervix of a gilt.

"There is a disadvantage, however, in using rather rigid catheters because while one is probing to get the catheter into the uterus there is a possibility of causing damage and we do get some bleeding occasionally. So although these type of catheters may be used, I still prefer to use the rubber catheter myself. There is also the possibility of using an inflatable rubber cuff at the tip of the catheter to prevent the semen flowing back, but I think the design of the cuff needs looking into. So much for the technique of A.I.

"The technique of semen collection and the dilution of the semen that we use will be demonstrated to you in a film we shall show early this afternoon and so I shall not go into details of that here. It is sufficient to say that the majority of boars that we have had to deal with have been trained easily to mount a dummy sow, and the semen is easily collected by means of an artificial vagina. In the laboratory we have worked on a number of different diluting fluids in order to investigate the longevity of the sperm. We tried first the common yolk-citrate or yolk-phosphate buffers as used for bull semen and we found the sperm did not maintain their motility in these diluting fluids when the semen was cooled to about 5°C. If we used glucose or glycine with the egg yolk we got a better preservation of motility.

"For our initial experiments we used as a diluting fluid the yolk-glycine buffer. To this we added in some instances antibiotics and in other instances we left them out. The antibiotics were penicillin and streptomycin added at the rate of 500 units per ml. of diluent. You will see from Tables I and II, also on page 4 of our paper, that in our laboratory experiments the pigs were tested with a vasectomised boar for the onset of heat. When inseminations were carried out on the second day we got relatively good results with semen used on the day of collection and with antibiotics in the diluting fluid. Out of 65 pigs inseminated 60 per cent. farrowed or became pregnant and the average litter size was 11. The results were lower without antibiotics in the diluting fluid. The most striking factor was that, although motility of the sperm was fairly well maintained for a day or two, inseminations with semen that had been stored resulted in a big drop in the conception rate. After one day's storage we got only 35 per cent. of our animals pregnant. However, the results under these laboratory conditions, using semen not more than one day old, were good enough to suggest that this technique might be put into practice in the field on a small scale. Mr. Holt from Dartington Hall was the first to set up a commercial artificial insemination service for pigs, we soon followed at Cambridge and Mr. Madden started in Hampshire.

"The scheme for A.I. in pigs was dovetailed into that for the cattle breeding programme, and the semen was used mainly on the day of collection. It was diluted, and the inseminators who had inseminated cattle were allowed to carry out insemination in pigs.

"You can see from Tables III and IV that the results we got under field conditions in Cambridge were very much lower than we would have expected from the laboratory trials and we were rather disappointed, to say

the least of it. We have a few more figures to add to those published in Table III. We have figures now for March and April of this year, but they are very little different from those which are published and we cannot say we get a farrowing rate of more than about 30 to 40 per cent. from those pigs that have been inseminated under field conditions. You will notice that there is a very big discrepancy between the conception rate that we calculated at three months and the actual number of pigs which farrowed. For this work therefore we have to follow up the results very carefully to get accurate figures on farrowing.

"We have tried to analyse the discrepancy between laboratory results and those that were obtained in the field, and it seems to us that the greatest difficulty is the diagnosis of heat in pigs which are kept on the small farms where artificial insemination is done. The majority of farms that are visited are small farms which keep perhaps two or three breeding sows—there is no boar anywhere near—and the farmers may be ringing up to have inseminations done when the animals are not definitely on heat. The time of insemination during heat is very important for good results. In general, a pig will be on heat for about three days. That is the actual time when she will take the boar. Ovulation usually takes place about the middle of heat, about 36 hours after its onset.

"In the pre-heat period many pigs will show symptoms of coming on heat—swelling of the vulva and reddening and so forth—and it seems quite possible that farmers are calling up for insemination at this time, when the pig might not take the boar for another day or two. Therefore, it is quite possible that inseminations under field conditions are being made too early—or too late. If a pig has been on heat for a couple of days and is still standing, for instance when one presses on her back she would take the boar but insemination would not result in conception. The question of getting farmers to know when insemination should take place is causing big difficulties.

"We did analyse our results on the basis of whether inseminations were carried out on large herds or very small herds, and the farrowing rate increased when we carried out inseminations in the larger herds. We think that probably it is in the larger herds that we have more experienced pigmen who are capable of diagnosing the heat periods correctly and they are telling us the correct time for coming to inseminate their pigs. That covers the main points we wanted to indicate in this paper.

"I think we can say that there are some encouraging features and some rather depressing ones. It is encouraging that the boar is an animal from which it is fairly easy to collect semen, so we can work with fresh semen at this early stage when it is not possible to store the semen for any length of time. We are trying to improve on the yolk-glycine diluent we are using. There is some indication from other countries that diluents containing milk may be better than those containing egg yolk. I do not think the storage problem will be insuperable and as we continue work on this subject I think we shall be able to get better conditions for storing semen.

"Apart from diluting fluids we have to work out the optimum temperature for preservation and I think that temperatures rather higher than those used for storing bulls' semen may be preferable. We still have to work out the optimum volume that should be inseminated. In one experiment I found that in gilts there was no difference whether we inserted 200 ml. or 100 ml. Some other people have obtained successful conceptions with as little as 50 ml. of diluted semen, but there is some indication that the larger volumes may assist the sperm to traverse the uterus.

"The most discouraging feature is the low farrowing we are getting in the field experiments; and because of this I think we shall have to go rather carefully in these initial stages in our method of advertising artificial insemination in pigs. Quite a lot of farmers want this service, but we should be very careful in talking to them to say we are still in the early experimental stages and that we have done laboratory experiments which show that the technique is feasible but that it may be a year or so before we have got sufficient practice in the field to make it a very worthwhile proposition. We must go rather carefully because it is a service that will do a lot of good to the country, but we do not want it to get a bad name at this stage.

"Veterinary practitioners may be called in to help farmers wanting to carry out artificial insemination privately for disease control, and I think they are on a better wicket than we are because on a private farm one has much more control over the pigs, knowing more precisely the time of heats, and one is not faced with the problems of using high dilutions of the semen and of storing it for any length of time." (Applause.)

The Openers

Mr. D. H. L. Madden, in opening the discussion, said: "I am very honoured to be asked to open the discussion in front of this eminent gathering.

"Apparently there are two ways of dealing with a congressional paper. One may tear a piece off and critically engulf it with bovine complacency, pausing only to regurgitate the bolus together with a belch of destruction! Or, one may gnaw it entirely into minute fragments, and, cleaning one's whiskers, make a nest of the particles and retire with mouse-like satisfaction in equal disarray! I propose to do neither! The paper we have just heard ties up the knots of the recent developments of pig A.I. so well that it is very nearly beyond basic criticism.

"How very proud of and how deeply indebted to Messrs. Polge and Rowson we must be for their continued world lead in the science of animal reproduction! When almost any major advance is announced, one may be sure that the Cambridge workers are but rarely unassociated with the discovery. But this brilliant team are not purely backroom 'boffins' unrelated to practical field issues. What I admire about their approach is that they seize the basic requirements of a problem, tackle it realistically in the laboratory and with research animals and then carry their banner into the field themselves, albeit with the self-effacing remarks we have heard from Dr. Polge to-day.

"Perhaps the worst we could say of them in the case of pig A.I., is that the results tend to indicate that they have 'jumped the gun' a little. But the starter has not called them back and I am proud that the Hampshire Cattle Breeders are yet again to the forefront in pioneering field trials in support of initiating the commercialisation of pig A.I. It is essential that the research work now be backed by large-scale field operations before critical judgment can be given.

"I would make a plea that all of us who enter this field of work collaborate in our efforts and pool our experiences and information. Let us, too, be rigorous in the collection of that data and not allow the laziness and inaccuracy experienced in dairy cattle records, to occur again. Subsequent loss of valuable information, or the difficulties in extracting and co-relating interactions can set investigators overwhelming problems later. If any practitioners have clients who wish to make use of the technique, we shall be glad to supply them with record keeping cards to standardise our approach. Invaluable data that might otherwise go astray could be analysed centrally.

"The pig insemination data at the Hampshire Cattle Breeders' Society is not spectacular in the early work.

238 1sts done 57 farrowed = 24 %
54 repeats 15 farrowed = 28 %
} Average litter size 9.0.

We have a stud of one Large White and five Landrace boars. Great difficulties, apparently insuperable at the time but amusing in retrospect, were experienced in obtaining regular collections. Our pantomime efforts were recorded at a meeting elsewhere and I am glad to say that little trouble is experienced from this direction nowadays. A modified artificial vagina has been used which I shall be pleased to show interested parties after

this meeting. The technique of dilution, extender, and insemination is essentially that originally devised by the Cambridge workers.

"I may be under a misapprehension but I believed large-scale pig A.I. was given impetus by the improved diluter containing glycine devised by Bishop. Accepting this belief we have, until recently, used this formula. Being dissatisfied with the keeping quality of our boars' semen at +5°C. we have commenced limited examinations of diluting fluids at room temperature. No inseminations have been performed using other diluents, but I find it remarkable that several other extenders will support equally satisfactory motility. Whilst I agree that motility may not be the acme of criteria with regard to fertility potential, it would probably be fair to say that immobile sperm had very little chance of fertilising. The duration of *bovine* spermatozoa survival in egg yolk citrate at +5°C., as indicated by motility, outreaches its age limits of economical fertility level by easily three times. On the fourth day the fertility drops markedly. The *boar* semen in this laboratory in glycine egg yolk diluent is largely dead at the end of 48 hours. To make an analogy, it is surely only to be expected that the corresponding highly fertile interval, using boars' semen in such a diluent will be only for a few hours after collection. No pregnancies have been obtained whatsoever, by us, using semen over 24 hours old with 67 inseminations.

"The *p*H of the raw semen after filtering off the jelly in this laboratory tends to be rather higher than we expected, ranging from 7.1 to 8.3. The higher the *p*H, the more immotile sperm are encountered in raw semen assessment. It is desirable to dilute with an extender whose *p*H is approximately equal to that of the semen particularly when its buffering potential is weak in comparison to the accepted sodium citrate bovine semen extenders in use. This requirement is exaggerated by the lower dilution rates necessitated by the comparatively low density of raw boar semen. The proportional part of the inseminated material that the actual accessory fluids form in pig A.I., is far, far greater than that in cattle A.I. and a renewed approach towards the percentage composition of the extender is perhaps needed. Otherwise, the proportions of ingredients present in optimal concentration initially, are vastly distorted or depleted by the volume of added semen.

"I am honoured to point out *via* a private communication just received from our Norwegian friend, John Aamdal, that, using deviations from the techniques and diluent employed in this country he has obtained an overall farrowing rate on 122 sows and gilts of 60 per cent. 44 of these were inseminated from the Oslo Veterinary College, 31 of which farrowed = 70 per cent., average 9.8 piglets. 78 were performed by practitioners of which 41 have farrowed = 53 per cent., average 10.3 piglets. Only two of the pigs which returned to service have not farrowed to repeat services. He points out that the percentage non-returns at six weeks is almost 100 per cent. diagnostic of pregnancy.

"Again, contrary to the experience at Cambridge, the drop of farrowing rate over non-return rate is very small in *our* experiments and could almost wholly be accounted for by unnecessary reticence on the part of the farmer to supply prompt and accurate data. Only two apparent pseudo-pregnancies have been recorded—the animals returning to heat at full-time instead of farrowing.

"Despite pig breeders' criticisms that fertility levels are much higher in natural service than we have all so far experienced with A.I., there appears to be a remarkable apathy on their part to produce reliably large numbers for comparison. It is of no great value to us to know that in certain herds conception rates appear to be much higher when the service data are not given publicity as well. Comparable figures essentially require only one service during the heat, witnessed reliably, with no possibility of further coitus. Furthermore, barren pigs must be included in the data! One frequently encounters, even in these days of comparative enlightenment, dairy cattle breeders who maintain that natural service fertility is higher than artificial breeding levels, but I have yet to encounter such a case which will substantially stand up to examination for comparison by our standards. After all, the conception rate, regardless of the number of services, of most A.I. cattle organisations would be pitiful, if it were much lower than 90 per cent. of the breedable cattle in calf *ultimately*. I would welcome as much pig natural service data as any of you can supply.

"Whilst management of the oestral pig and the timing of the insemination may play a part in success, it still appears to me important that the original experimental results were based on inseminations largely subsequent to what amounted to coitus by a vasectomised boar. In the rabbit and in the cat, we have cervical stimulation *via* coitus inducing or advancing ovulation to coincide with the presence of the spermatozoa. These species are reputedly of phenomenally high fertility. They, too, are multiparous animals with long tubular uterine horns. If we accept also the phenomenally high conception rates for the pig in natural service as being indisputable, is it possible that we are confronted here by a similar hormonal advancement of ovulation? It is said elsewhere that two services produce larger litters and this practice has become widespread in pig breeding. I would postulate that out of a 90 per cent. possible conception rate to first service one might deduce from present data available that only a 30 per cent. lowering can be attributed to the unsuitability of diluent and technique because the semen is being used only after a few hours old at room temperature. The semen will survive sufficiently well in a variety of extenders for that length of time. A further 30 per cent. lowering of conception rate may be due to the failure of eggs and spermatozoa at the time the eggs are present in a fertilisable state. Since it is apparently relatively easy to get 25 per cent. in pig *in spite* of the management, technique and diluent involved, it would appear to be probable that the difference between the experimental inseminations made at Cambridge and the field work experienced elsewhere in this country involves mainly the lack of coitally induced advancement of ovulation.

"May I also make a plea against the repetition of the hypocrisies that have possibly all but dammed the production of expected improvements through a decade of dairy cattle A.I. It is only recently that breed societies have begun to admit certain failures through the transmission of obviously undesirable recessives. The negative approach in avoiding close mating to cover up undesirable recessives in cattle breeding must not be perpetuated here. One of the first principles of constructive breeding is to get a clear idea of what one requires in the way of characteristics. The second principle is to go for those characters as directly and as rapidly as possible.

"To me it is obvious that there are far too many breeds of pig in the U.K. Surely, for instance, a clear, practical and scientific idea of desirable characters can be devised between compromising parties under the National Pig Breeders Association, based on the requirements of bacon factories. With pig A.I. in its infancy, we have a golden opportunity of commencing a realistic national effort towards a constructive breeding policy. Our boar should first be mated to two of his own daughters and his subsequent fate judged by the results. Let us not be ashamed of the demonstration of transmitted undesirables (in the pig the known factors are manifold) but rather glad that we can pounce on them and eliminate them, instead of sticking our heads in the sand as we have done so long with dairy cattle. We are dealing with a multiparous animal which makes our task even more a simple and economical practicability.

"Let there be a clear tie-up between the desirable carcase and outward appearance, without the meaningless frills with which cattle breeding is festooned. Let the material production rule the issue rather than fancy niceties of appropriately fed contours, colour, and texture which can be altered so materially by methods of feeding. Records must not be limited to conception rates but include survival rates at 24 hours, weaning survival rates and weights and then, in addition, subsequent carcase gradings and weights.

"Whatever our breeding plan, let it be an agreed scientific one between experts in genetics and live-stock improvement. Let us, at this early stage, in handling the enormous potentialities of pig A.I., almost within our grasp,

hold constructive meetings between all parties concerned. Let us replace minor and unimportant differences of opinion by facts determined by geneticists and really make an effort to exploit the science of breeding in a way that has not yet proved possible with dairy cattle. Research workers, and veterinary surgeons at A.I. Centres will provide the technical ability in the near future you can be sure. A.I. Centres should, for instance, plan to progeny test their own boars. General practitioners can play their part in making sure that their clients' pigs genetical potentialities are used to the full by proper methods of feeding and managements. One and all, now is the time to give your support to Messrs. Polge and Rowson's initiative."

Mr. A. F. Holt said: "Mr. Madden has eulogised our two authors far better than I can do so I should simply like to associate myself with his remarks. The work you have before you to-day is typical of that now produced at Cambridge, being revolutionary and of practical application. Purely because of the help and open-handed information received from Cambridge, A.I. in pigs was put into practice on a commercial scale at Dartington. Our results have been disappointing. The service was started in April, 1955, and, up to the end of April this year, the overall farrowing conception rate is 14 per cent. of the 1,114 sows inseminated.

"On the question of non-return figures compared with farrowing conception rates, we have had similar experience to that of Dr. Polge, the non-return figure at three weeks being 71 per cent. The farrowing figure is rather lower than is really the case, since it includes results during the first six months which were very low, whereas the present farrowing rate is 26 to 30 per cent.

"Following the optimism which accompanied the three weeks non-return figure was acute concern when the true farrowing rate became known and it was clear that investigation was necessary. Detailed notes were therefore taken at each insemination and I have some figures abstracted from the facts accumulated since November, 1955.

"Of seven sows inseminated on the same day as notification of heat 14 per cent. farrowed, of those first seen on heat the day before insemination 22½ per cent., two days before, 14 per cent., while those on heat three days before being inseminated had a farrowing percentage of 33⅓. Since there were only six inseminations in the last category, however, the rate is of doubtful significance.

"One of the first obvious signs of heat in the pig is swelling of the vulva. Pigs showing a very swollen and very red vulva had a conception rate of 24 per cent., with some swelling 17 per cent., and with no swelling 12 per cent.

"The better the sow stood for insemination, the better the conception rate. For those which stood well the rate was 21 per cent., fairly well 17 per cent., and for those which stood badly 13 per cent.

"Our technique at Dartington is rather different from that at Cambridge in that the semen is contained in plastic food bags and a polythene catheter is used for insemination. It has been found that given sufficient time most of the semen will enter the uterus by gravity, being carried forward in waves by contractions of the uterus. Sows inseminated by this 'gravity' method had a conception rate of 21 per cent. Where a small amount of pressure was exerted the rate was 22 per cent., but where considerable force was needed to expel the semen the rate fell to 14 per cent.

"A certain amount of semen is often expelled by the sow during or shortly after insemination and an analysis of behaviour in this respect has been made. Where no semen was expelled the conception rate was 18 per cent., where a little was expelled it was 20 per cent., and where there was a considerable quantity 27 per cent. These figures are surprising and one would hesitate to attempt to explain them at this stage of our knowledge.

"The low conception rate obtained tempted us to do two inseminations on some sows; these were done on consecutive days and affected 16 sows, giving a conception rate of 12½ per cent., whereas 102 sows which had only single inseminations had a conception rate of 18½ per cent. Double insemination, therefore, did not appear to be of any benefit.

"First and repeat inseminations gave almost identical results, 20.4 and 20 per cent. respectively.

"Some inseminations were carried out using the jelly fraction of the semen in addition to the usual diluted fraction. The jelly was separated at collection, after which it was soaked for three or four days in diluting fluid without the egg yolk. After this time the jelly globules formed a homogeneous mass which could be passed through a catheter. The conception rate in pigs without jelly was 19 per cent., and in those which also had 100 c.c. of the jelly solution, 16½ per cent. It would appear, therefore, that the jelly fraction of the semen is not essential to fertility.

"Conception in sows and in gilts gave almost identical figures, as also did semen used on the day of collection and on the day after where the rates were 20 and 21 per cent. respectively.

"The addition of antibiotics had an important effect on the conception rate. When no antibiotics were included in the semen the conception rate was 8.7 per cent., while the addition of 500 mg. streptomycin raised this to 17 per cent. The inclusion of both streptomycin and penicillin gave a further improvement and raised the figure to 25.7 per cent.

"Now come some surprising figures. In those females in which inseminations were intra-uterine, the semen flowing away without any resistance, the conception rate was 13½ per cent., whereas intra-cervical inseminations gave an appreciably better fertility rate of 35.8 per cent. In the former group there were 22 sows and in the latter 31. This is rather puzzling and needs further investigation. A study was made of a group of pigs with three characteristics in common in each animal. Those which stood well to the insemination and had very swollen vulvae had a 35 per cent. conception rate, whilst those pigs of this group which were, in addition, inseminated on the day following notification of heat had a conception rate of 46 per cent. It would appear, then, that where these three factors occur in the same pig the fertility rate approaches 50 per cent. Nevertheless, it must be borne in mind that out of over 200 inseminations only 13 fell into this group.

"I agree with the authors about the problem concerning the diluting fluid. In the figures which I have been giving you all inseminations were carried out with the glycine diluter, although this has now been discarded in favour of citrate diluter which does not store semen well at 5°C. but maintains good activity if stored at room temperature. In addition, some inseminations are being done with semen diluted with heat-treated skim milk which must be stored at 5°C., under which conditions sperm activity is well maintained.

"One point which occurs to me is how the diluter for the semen affects the ovum—a question which probably does not arise in the cow because of the small amount of semen used but may be of some moment in the pig where a large volume of fluid is injected into the uterus.

"A problem which has been encountered at Dartington but not yet mentioned here is the question of oestrus after service. A high proportion of the sows inseminated have not returned and in fact have been expected by the owner to farrow but at about farrowing time return to oestrus again.

"I have given you a general view of the work done and the problems encountered by us in this field. May I again express my appreciation to the authors for the invaluable work which they have carried out."

The General Discussion

Mr. J. A. Moss (Bromsgrove) said that both Mr. Madden and Mr. Holt had praised the Cambridge workers for taking the lead in this field. He himself would at the present stage like to praise Messrs. Madden and Holt for having the courage to go first as they had done. All the workers had shown that artificial insemination in pigs was possible, and no doubt they would by their

experiments, with the additional work that must come from other people, iron out the difficulties of technique.

There seemed to be three main points on which work remained to be done. One, of course, was that of obtaining the right sort of diluting fluid. The present problems would almost certainly be overcome, so there was no need to worry about that aspect. The second concerned the introduction of semen into the sow. There appeared in that connexion to be a similarity with the early work in cattle A.I. in which there was such a difference noted between the results obtained by the research workers and those obtained by others when it was taken up. Dr. Polge did demonstrate the necessity for getting the sperm well up into the uterus, and one wondered how sure the experimental workers were that the technique of insemination in the field was as effective as that which they had adopted.

The third point was the ascertainment of the correct time to inseminate. At this stage another person was introduced into the team, the owner of the sow. The problem seemed to be one of the most difficult. It might be said that insemination should take place early or late in the second day, but it had to be left to the farmer to decide which was the second day. If there were a more objective method of detecting oestrus it would help. There was likely to be a difference in the working between white sows and coloured sows, and it would be useful to hear how the distribution of the sows had affected the Cambridge results.

In all the work there was a difference between semen with antibiotic and that without. Could it be said in what way antibiotics had caused improvement, or, alternatively, how significant was the difference in the figures in that connexion? (Applause.)

Mr. K. M. Tyrrell (Dorchester) said he would appreciate a few words from the authors on the actual laboratory techniques and standards used for the evaluation of the fertility of the boar, the motility, concentration and the quality of semen. It was obvious to anyone who had used A.I. that the boar must be "one hundred per cent."

Dr. R. F. Montgomerie (Beckenham) said he was sorry to have missed the introduction of the paper, but had noticed in reading it that it was thought they would be specially interested in A.I. from the point of view of disease control. One noticed the authors were careful to say A.I. *might* be a means of controlling disease, and only one example was chosen. Could any indication be given of the diseases the authors had in mind? Secondly, could a few words be said in the reply about the effect of insemination creating a high embryonic mortality?

Professor W. I. B. Beveridge (Cambridge) said he would like to ask Dr. Polge to speak further on the recommended time for insemination. The author was no doubt thoroughly familiar with the work done in South Africa by Burger, where there were very careful tests for the onset of heat and inseminations made at different intervals after onset. The optimum time was thought to be 12 hours, but that was not much better than zero hour or 24 hours, and 36 hours was a bit too late with Large Whites, yet this was about the time Dr. Polge was recommending. Burger had found, so Professor Beveridge understood, that with Large Blacks the heat period was a good deal longer and the insemination was desirable at a later stage.

Mr. K. O'Sullivan (Stoke-on-Trent) said that at his Centre they were hoping as time went on things would have been made easier for them through the experience of those who were now giving pig A.I. service. From what had been said and written on the work it seemed there had been a lot of headaches. There were many ups and downs—more downs than ups—and there remained much to be learned about breeding diseases and the physiological aspect of the oestrus cycle. Had the authors encountered any difficult boars inasmuch as they were temperamental or would not work or turned savage? It was fairly common knowledge amongst farmers that the optimum heat period, somewhere about eight or nine weeks after farrowing, gave the best results. That might have some bearing on the results mentioned in the authors' paper.

Mr. K. D. Downham (Cirencester) asked whether the authors had evidence with regard to the influence of nutrition, environment and season on fertility rates.

At one time he was working with a colleague who was carrying out some pig feeding experiments. One thing the experiments indicated was that pigs which were reared outside from the beginning and then put inside fared far better than those reared inside the whole time.

It was interesting to hear that not only the size of the vulva but also the colour was noted, and there were workers who attached a great deal of importance to the potential fertility of the female from such observations. They must not overlook those very important factors. Also, the climate in this country was very variable for the pig, which was naturally a rooter, and if they tried to make everything too stereotyped in the way of pig breeding they would probably be making a mistake. (Applause.)

Mr. J. G. Murray (Ledbury) said that there was, of course, quite a strong argument for the opinion that there were too many breeds of pigs in this country, but the profession should be very careful in advocating a drastic reduction in the number of breeds. In greatly reducing the number of breeds they might lose some genes which would in the future be required. Would Mr. Madden say whether he actually advocated a reduction of breeds or not?

The Reply

Dr. Polge, in reply, said he was interested to hear from Mr. Madden of the results obtained, through Professor Aamdal, in Norway. It could fairly be said that the results obtained at Cambridge, at least in sows which were known to be capable of producing litters, were very similar. The farrowing rate was between 70 and 75 per cent. when the semen was used on the day of collection. It was significant that there also appeared in Norway a considerable drop in the conception rate under field conditions. The differences encountered in the field must be due either to the technique or to the management. On the technique of insemination, Dr. Polge said he had not emphasised in his earlier remarks the possible importance of the stimulation of the cervix at the time of insemination. The experimental animals at Cambridge did have a mating with a vasectomised boar before the insemination, and in carrying out inseminations now an effort was made to stimulate the cervix with the catheter.

Mr. Holt had given some anomalous results and referred to the higher rate of conception when the insemination was intra-cervical as compared with intra-uterine. The explanation might be that if the catheter slipped through the cervix quickly there was very little stimulation at all. On the other hand, when it was difficult or impossible to get through the cervix there was probably a considerable amount of friction on the ridged cervix before the semen was injected, and it was very likely that that caused the release of oxytocin and corresponding activity of the uterus.

Stress should be given to the fact that, if stimulation of uterine activity was important in assisting the transport of the sperm towards the site of fertilisation, it was important to avoid frightening the pig or trying to restrain it too much at the time of insemination because this was likely to cause the release of adrenalin, which counteracted the effect of oxytocin.

As far as the suppression of oestrus after insemination was concerned, under experimental conditions Dr. Polge had never come across the phenomenon of pigs not returning unless they were pregnant, but under field conditions he had experienced that to some extent.

There was the question of how antibiotics helped the conception rate, and it was difficult to specify. One could make the guess that if insemination at intervals wide of the proper oestrus period was being carried out it was quite likely that some infection in the uterus might be caused. It was well known in cattle, from the

work of Mr. Rowson and his colleagues, that within oestrus it was very difficult to cause infection, but outside oestrus it was very easy.

With reference to the examination of semen samples in relation to fertility in boars, it was found in work on bovine semen that it was very difficult to lay down any standard for the *in vitro* tests one could carry out in relation to the fertilising capacity of semen. Probably the same thing applied to boars' semen. All Dr. Polge could say was that the boars he had used had all shown high semen quality. That was to say, the volume of semen produced was in the region of 200 ml. and the initial motility of the spermatozoa was high. Usually there was not the swirling motion of the sperm, as with bulls' semen, because that applied only to high density semen. The density of boars' semen was in the region of 100 million per ml.—just about 1/10th of the concentration of bulls' semen. It had been said that the proportion of abnormal sperm in boars' semen should not be above 15 to 20 per cent., but there were not enough figures available on abnormalities in boars' semen in relation to fertility.

Dr. Polge said that the question of disease control he would leave to Mr. Rowson. All he would say now was that as far as the demand for A.I. in private herds was concerned it was only in relation to virus pneumonia that he had come across it at present.

There was the reference to high embryonic mortality when insemination was carried out late in oestrus. In that connexion he had been quoting from other people's work which suggested that if fertilisation did take place rather a long time after ovulation, although the number of eggs fertilised might be normal, more of them did in fact die.

He was fairly well acquainted with the work of Burger in South Africa. It was true to say that Burger found that natural service right at the beginning of heat gave the same fertilisation rate as service 24 hours after the beginning of heat. The experiments were, however, well controlled and zero hour could be determined accurately. Zero hour was taken as the time when the sow or gilt actually stood to the vasectomised boar. Under field conditions that zero hour was very difficult to determine and there could be a swelling and reddening of the vulva perhaps some days before the pig would stand service. That was why inseminations should probably not be carried out until after the first signs had been seen.

Under field conditions at Cambridge diluted semen was being used and if insemination took place rather closer to the time of expected ovulation one would expect better results than if it took place at the beginning of heat, when the sperm must live for 24 hours or more before meeting the egg.

In regard to nutrition and fertility, Dr. Polge was afraid he had no experience, except for the fact that Mr. Pomeroy, who was working in the same laboratories for some time, did collect breeding data from a number of pedigree herds and it seemed possible that over-fat animals—those in show condition—very often failed to conceive, and so over-fatness should be avoided. (Applause.)

Mr. Madden, in reply, said that, in connexion with Mr. O'Sullivan's point, he had not come across any really savage boars. The animals tended to make a lot of noise and sometimes made passes at the people handling them but they were not actively belligerent.

It was apparent from cattle records that breeding too early after calving down did result in a very low conception rate, but Mr. Madden wondered whether it was correct to say that the best results were obtained by using the period that occurred about six weeks after farrowing. Most of his sows were inseminated in the first season after weaning at 8 to 10 weeks.

His remarks on the number of breeds were something he would have thought to be a widely accepted view. There was no question of one national breed being advocated or anything like that. But at the present early stage it should be quite possible for geneticists, given a proper chance and working in conjunction with those who have to deal with an ultimate product, to decide upon a pig which was going to produce piglets that were one hundred per cent. correct for the desired characteristics. It was a little disheartening to hear any adverse talk about the narrowing down of strains at the present stage because, quite obviously, the pig breeding world was bogged down at the moment by trying to run too many lines at once. There could be a compromise and he only wished to stimulate proper collaboration between interested parties which was not hampered by petty differences of opinion. (Applause.)

Mr. Holt said that the question of antibiotics was brought up and he would like to write on the blackboard the actual figures that applied to his centre regarding the use of antibiotics:

	No. of Inseminations	*Farrowed*
With streptomycin	169	29 (17.2)
With streptomycin and penicillin	89	23 (25.7)
Without antibiotics	276	24 (8.7)

With regard to difficult boars, his experience was that six boars were tried for A.I. and two had to be discarded from the experiment. Boars were found to be much more temperamental than bulls. The boar was very easily put off. (Applause.)

The Chairman, Mr. W. P. Stokes, said it had been a great privilege and pleasure for him to be Chairman and to listen to the presentation of, and discussion on, such an interesting and constructive paper. They were all very pleased to have had the authors and their co-workers with them to tell them something about a subject which, at any rate before the session began, he himself knew very little. The meeting would want to show its appreciation in the usual manner. (Applause.)

Foot-rot of Sheep

A Modern Approach to an Old Problem

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Introduction

FOOT-ROT has been a common disease of sheep in Britain since the 18th century (Youatt, 1837). The contagious nature of this disease was first recognised and demonstrated experimentally by Gohier in France in 1808. Treatises on sheep diseases written during the 19th century devote considerable space to controversy as to whether or not the disease is contagious. Curiously, doubt on this point has persisted right down to the present, and to-day many sheep farmers do not realise that it is a contagious disease. The reason for ignorance on this point is that the disease spreads by contagion only when the sheep are rendered susceptible by certain predisposing causes (especially lush, damp pasture) and in many flocks the infection is constantly present. Thus the incidence of the disease is largely determined by the predisposing conditions, which are therefore regarded as the actual cause.

The disease exists in most countries where sheep are kept, but generally it is confined to areas enjoying a good rainfall and carrying heavy pasture. It may occur at any season but outbreaks are mostly experienced at the time of year when there is lush growth of pasture.

Sheep of all ages are equally susceptible but in lambs the lesions are not so severe as in adults, as evidently the softer horn is not conducive to extensive underrunning. Goats are also susceptible but no other species is affected.

Clinical Manifestations

Attention is first attracted to the affected flock by severe lameness—usually in several sheep. Often more than one foot on the same sheep is affected, in which case the animal remains lying down unless forced to move.

In the early stages, on close examination, there is found moistness of the skin between the digits and separation of the soft horn from the sensitive laminae on the axial aspects of the digits. Little or no pus is noticeable and there is no appreciable swelling. The infection spreads thence across the sole and eventually up the walls, almost to the coronet, so that most of the hoof is separated from the sensitive laminae. In the great majority of cases there is very little pus. Over the sole the soft tissues may be covered with a small amount of cheesy material. When the laminae of the wall are affected there may be some excessive granulation.

If the foot is left untreated, portions—especially the sole—may heal and become covered with horn. This new horn usually again becomes separated and underrun by the infection which has remained active on the axial aspects of the digits or other parts. After some months this may result in there being two or three layers of loose horn over the sole.

Under dry conditions spontaneous recovery occurs in a proportion of cases over a period of weeks, but the disease is a very long-standing one and in some sheep lesions persist for up to a year or more if they are not treated.

Cause

Mohler & Washburn (1904) isolated *Fusiformis necrophorus* from lesions of foot-rot and regarded it as the causal agent. Several subsequent workers agreed with this view but none succeeded in reproducing the disease with cultures of this organism. Ludovic & Baizot (1928) found a spirochaete in lesions which they believed to be the causal organism.

In 1941 I published the results of research into the cause of foot-rot which showed that the primary causal agent is a large gram-negative bacterium with knob-like ends, *Fusiformis nodosus*. Also constantly present in lesions is a spirochaete, *sp. penortha*, which is regarded as an accessory causal agent (Beveridge, 1941). Both these organisms can be recognised morphologically and they have been found in smears from lesions of foot-rot occurring in Australia, New Zealand, U.S.A. and England.

F. nodosus has very exacting cultural requirements. The original isolations in Australia and U.S.A. were made by inoculating material from lesions on to the surface of agar plates. Colonies of *F. nodosus* developed sufficiently well for one to recognise them and make subcultures. During the last five years repeated attempts have been made by myself and other members of the Department of Animal Pathology to isolate *F. nodosus* from cases of foot-rot at Cambridge. On no occasion were we successful although the organism was prevalent in smears. Furthermore, a strain of *F. nodosus* obtained from Australia has failed to develop sufficiently good surface colonies in our laboratory to enable one to isolate the organism in this way from material contaminated with other bacteria. A considerable amount of work has been done in an attempt to develop a medium on which the organism would grow well but we have been quite unable to produce as good growth as was obtained originally in Australia and the U.S.A. The reason for this failure remains a baffling mystery.

In smears from lesions, *F. nodosus* sometimes presents a curious phenomenon. The large rod-shaped organism is surrounded by smaller gram-negative bacilli arranged at right angles to it (see Plate).

Control

The demonstration of the causal organism finally settled the old controversy about the nature of the

disease. Foot-rot must now be regarded as a specific contagious disease. Moreover, the occurrence of the causal agent seems to be limited to the diseased foot of the sheep or goat. It will not multiply in soil or faeces and in nature it survives at most one week away from the host animal. Based on this knowledge a method of controlling the disease by eradication has been evolved and put into practice. The main features of this method are:—

(1) An eradication campaign is best carried out when the incidence of the disease in the flock is low. It should not be attempted while the disease is actively spreading because (*a*) animals in the incubation stage of the disease cannot always be detected, and (*b*) there is a possibility that infection might be transferred on fomites when the sheep are in a susceptible state. In breeding flocks segregation of affected animals is not practicable until after weaning. Thus late summer is usually the most suitable time to undertake eradication.

(2) All sheep are examined and the infected ones segregated. Every sheep on the property must be turned up and each hoof closely examined. Any hooves that are misshapen are pared. In addition to frank cases of foot-rot, carrier animals must be detected. These are not lame but have a pocket of infection under the horn or on the skin between the digits. If the skin between the digits is hairless or moist with exudate the sheep must be regarded as a probable carrier.

(3) The feet of the healthy sheep are disinfected with 5 per cent. formalin, either by swabbing it on or by passing the sheep through a foot bath. These sheep are then put into a field that has not had sheep in it for at least two weeks.

(4) Those sheep which have foot-rot or are regarded as carriers or suspects are treated therapeutically along conventional lines or, if convenient, they are sold for slaughter. There is a strong tendency for recovered sheep to suffer relapses, therefore sheep that have been cured should be kept separate from the healthy flock until they have all passed two successive critical examinations with an interval of at least a month.

On some farms in this country attempts have been made recently to stamp out foot-rot by repeated treatment but without troubling about segregation. With very small flocks this may prove satisfactory but with flocks of any size I do not think it is advisable. It means that the whole flock has to be handled every time the infected ones are treated or examined, and furthermore there is a risk of some spread of infection to fresh animals even during non-epidemic periods. At best, success may be attained by more work than necessary, at worst the infection will trickle on, or light up from relapsed cases after it is thought to be stamped out. It would be unfortunate if such experiences were to lead to the method of controlling foot-rot by eradication falling into disrepute.

Therapy

Of the greatest importance is the proper surgical preparation of the foot so as to expose completely the infected tissues for application of the antiseptic. Youatt described the essential operation very well some 120 years ago: "Every portion of horn that is in the slightest degree separated from the parts beneath must be cut away." Farmers are usually too conservative and are needlessly afraid of damaging the foot.

When all infected tissue has been exposed, a cure can perhaps be obtained in most cases by application of any of a number of good antiseptics. Before the antibiotic era 10 per cent. formalin was probably the best. More recently several investigators have claimed better results from 10 per cent chloramphenicol in alcohol (Stewart, 1954; Sambrook, 1955; Penny, 1955; Harriss, 1955a), though Littlejohn (1955) and Filmer (1955) seem to consider that as good results can be obtained with formalin. Harriss (1955b) obtained good results from the application of terramycin ointment.

My experience is that it is important to re-examine and, if necessary, re-treat all feet within three or four days of the first treatment. In an extensively diseased foot not infrequently a small pocket of infection will remain, perhaps because it has not been exposed during the initial paring: this can be found and treated effectively when a second treatment is done only a few days after the first, but if the foot is left for a week or two the infection will have spread to involve again a large part of the foot and so treatment may again fail to bring about a complete cure. When small numbers are involved, treatment is best repeated every two or three days until all are completely healthy.

Diagnosis

When a number of sheep in a flock are affected, a diagnosis can usually be arrived at by clinical examination. Where only one or two animals show lesions and these are not fully developed, there may be uncertainty. Smears, provided they are from material carefully taken from an advancing edge of the lesion, can be used to confirm the diagnosis. The spirochaetes are nearly always numerous and easily found and recognised in a smear stained by carbol fuchsin or gentian violet. The finding of these organisms is sufficient evidence on which to base a diagnosis because they are, I believe, rarely found in lesions other than foot-rot. *F. nodosus* is never present in large numbers and frequently is difficult to find in an individual smear, so inability to find this organism should not lead to a negative diagnosis. So distinctive is its morphology, however, that finding a single organism justifies a positive diagnosis.

Other common causes of lameness in sheep are as follows:—

(a) Foot abscess. This is the name adopted in Australia for the condition analogous to "foul-in-foot" in cattle. Only one foot on a sheep is involved and there is swelling above the coronet or between the digits. An abscess forms and when this has discharged there is left a sinus. This condition is caused by *F. necrophorus* which is probably widely distributed in the alimentary canal and faeces of herbivorous farm animals. The essential lesion of

Smear from case of foot-rot showing *F. nodosus* surrounded by smaller bacteria, also spirochaetes

foot-rot—underrunning of the sole—is not present, so diagnosis presents little difficulty.

(b) Contagious pustular dermatitis affecting the skin of the lower part of the limb may cause lameness in a number of sheep at the same time. This condition is not likely to be confused with foot-rot because on close examination the hoof is found to be normal. " Strawberry foot-rot " is an ill-defined condition and hence the term should be discouraged. It also affects the skin and not the hoof.

(c) " Scald " is the popular name for an inflammation of unknown aetiology affecting the skin between the digits. Lameness may suddenly appear in a large proportion of the flock. The lesions consist mainly of redness of the skin of the interdigital space and there is no underrunning of the horn of the sole. Possibly one cause of " scald " is penetration of the skin by larvae of *Strongyloids* spp. On the other hand some outbreaks are evidently precipitated by frost. The condition usually disappears spontaneously after a few days providing there is no foot-rot in the flock. If foot-rot cases or carriers are present, the " scald " may usher in a severe outbreak of foot-rot. It may be difficult or impossible to differentiate between an early case of foot-rot and " scald " by clinical examination.

(d) Foot-and-mouth disease must be kept in mind when an outbreak of lameness occurs. This disease is often mild in sheep. The mouth lesions may not be noticed and the most conspicuous symptom may be lameness.

Discussion

The method of control by eradication outlined above was introduced some 15 years ago in Australia. It has been shown to be effective on a considerable number of sheep properties there (Beveridge, 1941; Proceedings of Conference of Veterinary Officers held at Young, N.S.W., 1953; Pryor, 1954) and on some in New Zealand (N.Z. Dept. of Agric. Annual Report of the Anima! Res. Div., 1949-50; 1950-51) and in two small flocks in this country. It must be admitted, however, that it has not yet been adopted as widely as one would wish. One reason for this is that it requires vigorous measures to be taken at a time of the year when foot-rot is not troublesome. During outbreaks of the disease the sheep owner is driven to spending money in combating foot-rot, but when it is quiescent he is loath to do so. Another obstacle it that usually segregation of affected animals is difficult to arrange and upsets normal management routine.

In 1953 in Australia the Commonwealth Scientific and Industrial Research Organisation convened a Conference on foot-rot because of the continued prevalence of the disease in Australia and the contention of some sheep owners that control, as outlined above, was not satisfactory. At this Conference it was reported that in Western Australia, and in Tasmania, foot-rot was controlled by departmental regulations involving quarantine measures such as are used with certain other contagious diseases. It was considered that in both these States real progress had been made towards total eradication. The Conference passed a unanimous resolution affirming that foot-rot can in practice be controlled by the eradication method outlined.

In Australia eradication is helped by the dry summer period. Wet summers may make eradication more difficult in this country, but the fact that the flocks here are generally much smaller should more than offset this disadvantage.

In the control of any disease, experience in the field is necessary to find where the practical difficulties lie in applying the principles under local conditions. It is important to gather and to pool experience in eradicating foot-rot from farms in this country. Some veterinarians have been supervising work along these lines during the last year or two and I look forward to hearing from them during the discussion.

Summary

The fact that foot-rot is a specific contagious disease due to an obligate parasite is still not generally realised. It has been shown overseas, and on a small scale in this country, that foot-rot can be eradicated from farms. The detection and segregation of all infected animals, including carriers that are not lame, needs care but is practicable under farm conditions. It should be undertaken when the incidence of the disease is at a low ebb, not during an outbreak. The infection lives in the soil for less than 14 days. Infected sheep can be cured and eventually may be returned to the general flock, but they have a tendency to relapse so should be kept separate for at least a further month after they are regarded as cured.

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THE SPEAKER'S INTRODUCTION

The Chairman, Mr. J. G. Murray, in introducing the author, said that Professor Beveridge was an eminent authority on the subject of foot-rot in sheep and Director of the Department of Animal Pathology at Cambridge. They knew that the author's name was associated with painstaking and thorough research work on basic problems and, what was more, the translation of that work to the practical field. The paper was in their hands and they had no doubt read it. Equally, there was no doubt they would have noticed the manner in which it was

presented. The paper was a simple statement of the findings and facts as they appeared to the author, expressed with clarity and brevity.

Professor W. I. B. Beveridge said: "My task is very easy this morning because I have brought along a film which says practically all I want to say, so my introductory remarks will be extremely brief. The paper is intended to try to get across the idea that foot-rot must be regarded as a specific contagious disease which can be eradicated in the way that many other specific contagious diseases can be. The organism does not live long in the soil, not more than about a week, and if the carrier animals can be dealt with the disease will not attack the animals placed on a clean field. That is the general idea, but the translation of it into practice is a more difficult problem, especially under English conditions in which summers are frequently wet and foot-rot might be spread at all times of the year.

"In Australia, in the southern part, we have the fortunate circumstance of a long and dry summer and this provides an ideal situation for eradicating foot-rot. Nevertheless, we have not solved the problem in Australia at a practical level. Foot-rot is still very prevalent in New South Wales and Victoria, and the practical eradication on large properties is not an easy matter. In some States, such as Tasmania, it is a notifiable disease. The policy of eradication has been accepted as the best means of controlling the disease. As to whether it is the simple answer in this country, I look forward to hearing your opinions.

"We will now see the film."

The film, entitled "Foot-rot and Foot Abscess", was then shown.

The Opener

The Chairman said they were very fortunate in having Miss Littlejohn to open the paper. Miss Littlejohn, who worked at Weybridge, had spent a considerable time on research on sheep. Her name was associated with enzootic abortion in sheep and other sheep conditions, and she had had a distinguished college career. Qualifying in Liverpool, he understood she had obtained her B.V.Sc. with honours, a most unusual distinction and, he believed, unique among women graduates.

Miss A. I. Littlejohn, in opening the paper, said: "First of all, I know I am expressing the feelings of all when I congratulate Professor Beveridge on his excellent summary of the condition of foot-rot and also on bringing along that splendid film. I wish it could be made available to farmers throughout this country. I do not know whether Professor Beveridge has any views on that, but it would be an excellent means of educating the farmers because there are many who doubt that foot-rot is a specific disease. I am not going to attempt to add anything to Professor Beveridge's paper in the matter of clinical manifestations, causal organism or diagnosis of foot-rot, but there are one or two points on which I should like to disagree with him on the practical treatment of the foot in this country.

"The first point may seem a minor one but to me it is a rather important one and concerns the preparation of the foot. Professor Beveridge, I am told, advocates rather drastic paring of the foot and does not object to causing haemorrhage. I have found, however, that when the use of the knife is so severe that it causes haemorrhage it is difficult to appreciate just when one has reached the junction between the underrun and the healthy horn. Naturally, it takes longer to pare a foot when one is anxious to avoid causing haemorrhage, but I consider the time well spent.

"As shown in the film, and as advocated by those who have to sell them in this country, secateurs may be used for sheep's feet in addition to the customary knife, but I prefer pincers, such as these (indicating) price 3s. 11d. I was a little alarmed by the point of the knife we saw in the film. I much prefer a knife about the size of *that*, which will stand frequent sharpening, and certainly not a chromium plated one because I like to sharpen on a scythe hone. I do not like a knife with a long tapering point. Probably the sheep do not mind, but I do not like the idea of driving a thing like that into my wrist if the sheep kicks. I am thinking of something more like a colt castration knife. I also like to have a small pot of formalin in which to put the instruments as I lay them down.

"If one is carrying out trials it is essential to do the paring oneself because shepherds are inclined to think that a rapid slash across the wall of the hoof is all that is necessary. It is advisable to choose a dry day following one or two wet days because sheep's hooves can be exceedingly hard after dry weather, but after two or three days of moist weather the hoof does soften up and it is easier on the fingers. I generally put sticking plaster on my fingers *before* I start on a batch of flinty feet.

"In this country flocks are generally small and therefore the question of treatment of animals in large groups does not arise very often. Even in large flocks, the animals are usually kept in a number of smaller groups, which can be regarded as separate units for purposes of eradication. Conditions in this country are by no means ideal. You all know what sheep folds look like on most farms. Each farm has to be treated on its merits but I would suggest that you make use not of the permanent sheep folds but of a concreted yard on which temporary folds can be erected. I was able to make a satisfactory foot-bath in one farmyard out of a good long pig-trough laid along the wall of a building, with a couple of farrowing crates on the other side of the trough. The sheep can be assembled in one part of the yard and then let out into another part fenced off with hurdles. I think it is essential to make the sheep stand on clean ground after they have been treated—on concrete, stone pavement or wooden boards—for an hour at least.

"For the treatment of the foot after paring, I strongly advocate the use of formalin. 10 per cent. formalin is, as you will soon find out if you splash it on your own hands, an effective astringent agent, in addition to being an effective agent against the specific organism, and primarily for that reason I prefer it to copper sulphate and to both of the antibiotics that have been used. The objection to copper sulphate is that, although it is cheap and marks the foot, it has the disadvantage of damaging the wool and is, of course, poisonous. It also hardens the hoof and if one has missed part of the horn and it has to be pared again a few days later it is a very difficult proposition.

"I have no doubt chloramphenicol is as effective as formalin for treatment of infected feet, and some would say it is more effective, although the evidence does not show it to be. But, admitting it is as effective, there is not the slightest doubt it is far more expensive. The cost of treating sheep's feet with chloramphenicol tincture is 6d. a foot, not 6d. a sheep. There may be three feet affected. Whether the 6d. covers two badly infected claws I am not quite sure. Terramycin is rather difficult to estimate because it is in ointment form and there is a certain amount of wastage depending on the operator, but it costs considerably less. The cost is probably a halfpenny or penny a foot.

"As for 10 per cent. formalin, I treated the whole of a badly infected flock of about 250 animals therapeutically and prophylactically over a period of 9 or 10 months with the contents of one carboy, price 56s. One disadvantage of formalin is that it gives off a strong and irritant vapour, but in this country there is generally a considerable breeze, and as one is usually working out of doors one is unlikely to be greatly troubled by it. The danger of splashing formalin into the eye is more serious. However, the danger is easily overcome if eye-shields are worn. Ex-W.D. eye-shields cost, I think, 1d. each. Formalin also does have an effect on one's hands if one is splashing it around, but rubber gloves are the answer to that, or one can just put up with it. It does not have the drastic effect of copper sulphate.

"In concluding, I should like to emphasise that it has been my experience in several flocks that it is possible to eradicate this disease completely provided one supervises, or preferably carries out the work oneself. But if one is content merely to give instructions and possibly one or two

demonstrations to the shepherd one can be disappointed. There can be breakdowns. I think the majority are attributable to insufficient preparation of the foot. Whatever one uses—whatever the farmer's purse will stretch to—is I think a secondary matter. The main point is to pare the foot completely and thoroughly—with or without haemorrhage—in order to allow the therapeutic agent to reach the seat of the trouble. Only in this way can the disease be controlled." (Applause.)

The General Discussion

Mr. R. Jones Pugh (Harrow) said that he represented Parke, Davis & Co. Ltd. He had been endeavouring to acquire figures which indicated how much foot-rot was costing the country each year. To date he had found nothing at all and would appreciate it if Professor Beveridge could give at least some indication as to what foot-rot means with regard to loss of condition, poor fleece, etc.

Professor Beveridge said that it was difficult to obtain an estimate. The desirability of getting a figure had been thought of several times but he could not see a starting point. If a sheep had foot-rot how much was the farmer losing? It depended on how long it was before the animal was treated and how much condition was lost. If the sheep were neglected it might die, which depended on the farmer. It seemed impossible to produce figures. Figures on the incidence of disease would be something concrete but he was afraid he had no information as to the incidence.

Mr. Pugh added that Mr. Thornberry in Dublin had stated that cures might be obtained with copper sulphate, formalin or preparatory ointments, but in many cases the condition returned; cures obtained with chloromycetin appeared permanent in all cases. That, Mr. Pugh thought, was one of the first points to remember for any policy of eradication.

Mr. S. T. Harriss (Ministry of Supply) said that he had greatly appreciated both Professor Beveridge's paper on the subject and Miss Littlejohn's description of the practical side of it, yet in spite of everything that was said he felt that without legislation it was more than likely that foot-rot, like the poor, would be for ever with us. It appeared that the average shepherd was quite incapable of realising the infective nature of foot-rot and, as Miss Littlejohn suggested, the members of the veterinary profession should do something about it themselves. The point was—how? If Professor Beveridge could solve the problem of how the veterinary profession could go out and do the work, especially the paring of the feet, that would probably help towards securing his ideal.

When paring the foot one often found between the claws a frog-like interdigital pad. It was like proud flesh and it continued to grow and was always a source of harbouring the infection. It seemed to recur and go on growing and was always associated with a sweaty condition. Short of a major operation it was difficult to see that anything could be done for such feet.

Mr. Harriss was glad that Professor Beveridge had exhibited the picture showing foot-rot shears. Eight years ago he had tried to buy a pair and had had to ask the Wilkinson sword blade manufacturers to make them specially as none were available from the veterinary instrument makers. Nevertheless the knife was still essential in addition to the shears. A great deal could be accomplished with the shears but the knife was essential to complete the operation. He did not mind drawing blood, and in fact thought it was a good thing as it showed when one had reached the limit of infection. He had not tried Miss Littlejohn's pincers, but would certainly do so—at 3s. 11d.!

There was, however, another problem on which he had very little information. Already he had advocated the use of several antibiotics but, if one treated the affected foot with antibiotics, what effect on the antibiotic had the subsequent foot-bath treatment of the rest of the feet? One manufacturer of an antibiotic had stated that copper sulphate had a definite inhibitory effect on the efficiency of that antibiotic. Under those circumstances it was rather difficult, having treated the affected foot, to put the animal through the foot-bath because it might undo all the good that had been done before. He had always been disappointed in the use of copper sulphate as a foot-bath. He had used only 10 per cent., but had not employed stronger solutions because one had to consider the amount of money the farmer or shepherd was prepared to pay out towards treatment of foot-rot. In some respects Miss Littlejohn, rather like Nasser, had "closed the Suez Canal to the veterinary profession". She had advocated 10 per cent. formalin and any farmer could go and buy formalin at the chemist's shop. If, on the other hand, the farmer must go to the veterinary surgeon —and chloramphenicol or terramycin have to be purchased through the veterinary profession—the veterinary surgeon remained interested in foot-rot. Miss Littlejohn has produced her pincers but has not produced her bottle of formalin. It was easier to carry round an ointment than bottles. Liquid in a bottle was easily spilt, and, as for chloramphenicol, it was very expensive stuff—he had lost pounds worth of it by breakages in sheep yards.

A point which had not been mentioned was the selection of parents in avoiding the incidence of foot-rot. The film had demonstrated certain pockets in the feet. One could not be quite certain whether the film had attempted to convey the meaning that foot-rot never started in those pockets, but when buying a ram he examined the feet carefully and avoided anything with such pockets. Similarly, when selecting hoggets to go to the ram he preferred to send those with bad feet to slaughter or sale rather than permit them to join the breeding flock.

Referring back to Professor Beveridge's paper, several points came to mind, for instance, foot-abscess might also be due to a staphylococcus, and "Strawberry foot-rot" was referred to as being ill-defined. He, Harriss, had described this condition at some length and the responsible organism had been identified by Thompson as a rhizobium which is of the same category as those that produce nodules on peas and beans.

Finally, Mr. Harriss put forward the suggestion that it should be possible to arrange live foot-rot demonstrations at country sheep fairs, agricultural shows and similar occasions.

Mr. W. T. Harrow (Manchester) felt it would be presumptuous to congratulate the author but he would like to thank him for spreading the gospel in Britain as he had done in Australia and New Zealand and many other parts of the southern hemisphere. The way to treat foot-rot was to go to a considerable amount of trouble in paring feet and checking up on every animal in the flock. The reason for the apparent success of the antibiotics over formalin in regard to non-recurrence of the condition was possibly that the antibiotics were so expensive that the user took good care to see the first shot was an effective one. An example should be taken from the Australians, who could shear a sheep in three minutes against this country's 20, in properly training and organising the shepherds so that such things were done in a really efficient manner. Mr. Harrow could not agree with the suggestion that they should recommend antibiotics rather than formalin because they were the perquisite, so to speak, of the veterinary profession. Surely their job was not to be drug pedlars but to do their best to help their clients. (Applause.)

The Reply

Miss Littlejohn, in reply, said the point had been brought up that antibiotics might be inhibited by copper sulphate and that animals whose feet had been treated with antibiotics should not be put through the foot-bath. This made it all the more desirable that the same agent, *e.g.,* formalin, should be used for therapeutic and prophylactic treatment of the animal. It was a good point that in flocks where the antibiotics were used they had been used by a veterinary surgeon and that probably meant that the foot was more carefully prepared beforehand. She knew that that did not apply to the work of Stewart

and Thornberry, in which formalin was compared with antibiotics. Nearly all published work concerned the efficacy of chloramphenicol or formalin by itself; Stewart did compare the two but it should be noted he tested the 10 per cent. formalin on only one foot of one animal. That was not a very adequate trial. Thornberry treated eight feet with formalin. But he used 50 per cent. formalin and that was probably too severe. Miss Littlejohn believed that if 50 per cent. formalin was used on a sensitive part it delayed healing. In Thornberry's work of comparing formalin with chloramphenicol, where the lesions were severe he got only 33 per cent. cures after only one treatment with chloramphenicol. She personally obtained a considerably higher percentage of cures (80 per cent. and upwards) in badly infected feet, with one treatment of formalin.

With regard to the economic loss, Miss Littlejohn had no statistical information, but in her own part of the country, which was Angus, she had heard people say that if it were not for foot-rot they would be quite happy because there was no other disease of sheep that caused them much trouble. (Applause.)

Professor Beveridge, in reply, said he had to thank Miss Littlejohn for the details; she had given an admirable dissertation on the treatment of foot-rot. He thought the differences between himself and Miss Littlejohn were rather more superficial than real, at any rate on the question of haemorrhage. Blood did of course tend to obscure the area on which one was working and it was better not to cut the foot if it could be avoided, but the most important thing was to pare the foot adequately. The farmer must have impressed upon him the need to pare drastically. If he was told not to make the foot bleed he would be cautious and stop at the first sight of blood, and consequently the job would not be done properly. If the farmer was told not to worry about a little bit of blood there was a better chance of the job being done thoroughly.

Professor Beveridge said that he had tried to arrange trials but it was not an easy thing to do. It was necessary to deal with large numbers and to follow up afterwards. As regards expense, even if it did cost a few pence more per foot to give a particular treatment, provided it was more effective the extra expense of the drug might not be very important as the principal cost was labour and professional charges. Whether or not the veterinary practitioner should do the treatment himself was perhaps a matter of opinion. The job of paring large numbers of sheep's feet was perhaps beneath a professional man but the supervision of the eradication programme was where the veterinary practitioners should come into the picture.

Mr. Harriss had raised some points, one being on the question of "Strawberry foot-rot". Professor Beveridge said he had not had experience of it and the observations in the paper were biased by some purely informal information received from Dr. Stamp who had investigated some work on the condition.

Next there came the question of how to get farmers to tackle the disease and the best way of going about it. An organisation with which they were all familiar, the Universities Federation for Animal Welfare, had been conducting a publicity campaign on foot-rot for about a year and they were very vigorously pursuing it by the distribution of leaflets to breeders and so on when the occasion required. The object was to wake the farmers up to the need for doing something. With the co-operation of the veterinary practitioner one hoped that some real progress would be made in the country toward getting foot-rot stamped out. (Applause.)

The Chairman, Mr. J. G. Murray, said that nothing remained for him to do but to thank Professor Beveridge for an excellent paper and Miss Littlejohn for so ably opening the discussion. All those who had spoken were to be thanked for their participation and for making the meeting interesting. He also wanted to thank Mr. Roberts, the Recording Secretary, who by his efficient arranging and handling of the details of the meeting had made the task of the Chairman an easy and pleasurable one. (Applause.)

Animal Disease from the Point of View of Human Medicine

P. G. ARBLASTER and A. P. PRIOR

Introduction

VETERINARY medicine has many advantages. Not for you the parable of the lost sheep. Not for you the problems of stress or the inflexible doctor-patient bond. This year we celebrate the centenary of Freud. As we invade private life to probe the psychological root of symptoms, human medicine enters a new phase. We leave the great infections to enquire into the complexities of the lonely and stressed mind.

Medicine is founded on the rock of doctor-patient relationship. Herein lies our strength and our weakness. The latter because the relationship sometimes obscures and perhaps inhibits epidemiological methods and preventive medicine.

We acknowledge the debt of medicine to the experimental animal. It will be recalled that Sherrington, working in a veterinary hospital, first defined the ventral nerve supply of the dog. The work of Pavlov is well known. Perhaps the conditioned reflex has never more happily been exploited than in Leamington Spa, the home of the dogs for the blind school.

The greatest link between veterinary and human medicine is that of infectious diseases and to these our paper is largely devoted.

Diseases of Practical Importance in South Warwickshire

Tetanus

The southern part of the county is pretty well supplied with horses and hounds. In addition it is, in parts, highly cultivated. We see occasional cases of tetanus—at the rate of about one every two years. Mostly these are associated with agriculture and seldom with farms or horses. Bacteriological proof is often hard to obtain. The older practitioners say there is a definite association of cases of tetanus with certain villages. These lie to the south of this town. No special conditions of soil appear to obtain.

The few cases we have seen in these parts have come from the area mentioned. But the number is too few to allow the drawing of any reliable inference.

It is not impossible that so far as many men are concerned they may be benefiting in this respect from National Service and immunisation from tetanus toxoid. But so many children in these parts ride and even do a certain amount of looking after their cattle that at some stage the question will have to be discussed of local policy with regard to tetanus immunisation of the young. As medical students we were inoculated and vaccinated against everything possible. We presume that any progressive medical school offers an even extended range of antigens to its undergraduates. What is the policy in veterinary schools? What policy do you pursue as individuals? We should think that the value to the individual veterinary surgeon would be high and such immunisation merits your serious attention.

Brucellosis

In a semi-rural area such as this brucellosis either in acute or chronic form is an item of the differential diagnosis of fevers both in children and in adults. It has been said that 15 to 20 per cent. of adult bovine cattle in this country are infected with *Brucella abortus*. Spread of infection to man is known to occur though its frequency in this country has not been established. Brucellosis is less frequent in urban areas, doubtless due to the more frequent heat treatment of milk.

The method of investigation used in suspected human cases follows a rather set pattern. The general clinical and laboratory procedures customary in attacking a case of fever of uncertain origin are elaborated. An intradermal inoculation with an antigen made from a whole organism suspension is used. This is said to give more reliable results than a more refined active protein-nucleate fraction of *Brucella* cells. Using a whole organism fraction positive skin tests of themselves do not necessarily indicate active infection although a negative one is showing evidence against.

Serum for agglutination reactions has often been taken by the time one gets around to skin testing. Serum agglutinations are not necessarily found in many cases of chronic brucellosis and in acute cases time must be allowed for them to develop. Various workers have isolated the organism from blood or marrow culture when no serum agglutinins could be detected. This phenomenon is not so rare as we would like to suppose and has been encountered also in *Salmonella* infections. There is an amount of documentary evidence that the level of serum agglutinins may be enhanced by the skin testing and that a further sample of serum taken 8 to 32 days after the skin test may show a diagnostic level of agglutinin titre. In the few cases on which we have tried this manoeuvre we have not found it of particular value, but it is probable that our experience is too small to be such a degree of help as we could have wished.

Finally aspiration liver biopsy has been used by certain authors. The resultant histological picture requires very careful interpretation taking into account all the other clinical and laboratory findings.

In this disease our interest is more in the human contact than in the animal sufferers. A few years ago, in Lancaster, Barrett & Rickards (1953) published 62 cases of chronic brucellosis collected in the course of 18 months. Half of these were connected with farms and one was a veterinary surgeon.

We have investigated one veterinary surgeon who accidentally inoculated himself with Strain 19. We obtained negative results. In the U.S.A. some figures have been published on the incidence of serum agglutinins in veterinary surgeons. It would appear that in Indiana the percentage incidence of a titre of one in 80 or over has been decreasing whilst it has increased in the country as a whole. Accurate figures for serum agglutinin titres either from the population or such specialised parts of it as veterinary surgeons or farm workers are not available in this country.

Leprosy

No word of apology is needed for including this disease in this discussion. The actual mode of transmission of the disease in ordinary circumstances is little understood.

There appears to be little doubt that a localised form of human leprosy can be conveyed to monkeys. But the disease is transient and rapidly cures itself. It is also fairly well established that rats can be given a disease indistinguishable from real leprosy and that the disease can be transmitted to the Syrian hamsters.

According to our information rat leprosy tends to occur where human leprosy does. This statement may be a little too sweeping. But nevertheless it is interesting to speculate upon. No fewer than two patients diagnosed as leprous have come to this area in the past 10 years. Since the disease is not indigenous it has taken time and some trouble to establish a diagnosis. We gather that other cases have been seen in other parts of the Midlands from time to time. Where we lack information is on the frequency or otherwise of the occurrence of rat leprosy in this country.

Disease Due to the Mycobacterium Tuberculosis

Historical

In 1868 Villemin succeeded in transmitting tuberculosis to animals by direct inoculation and in 1882 Robert Koch described the causative organism. Tubercle bacilli are divided by cultural and pathogenicity reactions into five types—human, bovine, avian, murine and cold-blooded. The first three strains are epidemiologically important. In 1898 Smith described their differentiation. The bovine bacillus in rabbit causes progressive disease followed by death, whilst the human bacillus produces a local lesion and general health is unchanged. Table I summarises these and other reactions.

TABLE I

DIFFERENTIATION OF STRAINS OF TUBERCLE BACILLI BY PATHOGENICITY IN LABORATORY ANIMALS

Strain of bacillus	Guinea pig	Rabbit	Chicken
Human	++	±	0
Bovine	++	++	0
Avian	±	+	++

In the nineteenth century milk was boiled on empirical grounds. In 1901, Koch stated (1) "human tuberculosis differs from bovine, and cannot be transmitted to cattle" and (2) "the extent of infection by the milk and flesh of tubercular cattle, and the butter made of their milk, is hardly greater than that of hereditary transmission and I therefore do not deem it advisable to take any measures against it." This *ex cathedra* statement restrained veterinary preventive medicine for many years.

Pathogenicity of Tubercle Bacilli in Animals

Since the work of Griffith in 1928 there has been little comprehensive analysis of tubercle bacilli strains in animals. Plum and Bang described abortion in Denmark cattle due to avian tuberculosis of the uterus whilst others have described lesions in cattle as insignificant when due to the same bacillus. Recent estimates of avian tuberculosis in fowl in the United States vary between 3.0 per cent. and 5.8 per cent. Ten per cent. of eggs from tuberculous fowl are said to contain live tubercle bacilli. Lovell & White (1940) in material offered for *post-mortem* found that 4.6 per cent. of dogs had evidence of tuberculosis. The organism was recovered in 22 cases. Of these, 18 were human and four bovine.

Lovell & White (1941) similarly examined 110 cats at *post-mortem* and found four with tuberculosis, an incidence of 3.6 per cent. This incidence, as that in dogs, is higher than in man.

Most infected animals will develop tuberculosis. The incidence of infection increases with domesticity. The pathogenicity of strains to individual animals appears constant and well defined. The occasional oddity, such as avian tuberculosis in man or human tuberculosis in cattle, is probably due to massive infection in unusual circumstances. Table II summarises this and other information derived from various sources.

TABLE II

NATURAL TUBERCULOSIS IN SOME ANIMALS IN WHICH THE STRAIN OF TUBERCLE BACILLUS WAS DETERMINED

Animal	Number of cases	Strain of tubercle bacilli		
		Human	Bovine	Avian
Horse	75	1	68	5
Pig	163	118	5	43
Fowl	13	0	0	13
Cattle	52	1	50	1
Cat	57	4	53	0
Dog	178	134	43	1
Sheep	64	1	22	41
Goats	20	0	19	1
Man	100	96·0	4·0	0

Bovine Tuberculosis in Man

Introduction

There is a universal decline of tuberculosis morbidity. Resistance to disease varies between races and parts of races. Death rates for a number of countries in 1939 illustrate this point (Table III).

TABLE III

DEATH RATE PER 1000,000 PERSONS. ALL FORMS OF TUBERCULOSIS, 1939

Denmark	34	Norway	86
United States	47	Eire	113
England and Wales ...	62	Poland	195
Scotland	70	Greenland	550

Bovine Tuberculosis

The first cases of indisputable bovine tuberculosis in man were described in England by Griffith in 1914. Both cases were male, one a butcher's assistant and the other a bricklayer, they both were unusual—they had typical pulmonary tuberculosis.

In 1930, Griffith reported 16 further cases and by 1937, 194 cases of pulmonary tuberculosis due to the bovine bacillus had been described in England. In the same year Gervois collected 260 cases from the world literature. Non-pulmonary disease due to the bovine strain is much more common. Table IV gives the incidence in various forms and compares 1937-38 with 1943-45.

TABLE IV

PROPORTIONS OF NON-PULMONARY INFECTIONS IN HUMANS DUE TO THE BOVINE BACILLUS IN ENGLAND AND SCOTLAND (COMPILED FROM WILSON, BLACKLOCK & REILLY (1952), AND GRIFFITH (1938))

		England	Scotland
		%	%
Abdominal	1937–38	82	81
	1943–45	65	65
Meningitis	1937–38	25	26
	1943–45	28	11
Cervical	1937–38	50	78
	1943–45	57	68
Bone and joint	1937–38	20	38
	1943–45	11	11
Genito-Urinary	1937–38	17	25
	1943–45	20	26
Total	1943–45	1,101 cases	25% bovine
Pulmonary	1938	3,103 cases	1·4% bovine

The incidence of disease in England and Scotland is different. Table IV also reveals a reduction of certain forms of non-pulmonary bovine disease.

The age and sex structure of the cases reported in Table IV were similar except that in the 1937-38 cases the highest incidence was in the 0 to 4 age group. In 1943-45 it had transferred to the 5 to 9 age group. This is probably associated with development of the Child Welfare Service and increased use of clean milk for infants.

The total incidence of bovine infection (pulmonary and non-pulmonary) for different areas in 1914 were estimated to be:—

	%
North-East Scotland	7·0
Rest of Scotland	5·1
England, North and Midlands	2·0
Wales	1·0
England, South	0·6
Ireland (320 cases)	0·0

In contrast bovine infection was responsible for 25 per cent. of non-pulmonary cases. This form of disease led to 1,600 deaths; of these, 550 were meningeal and 1,050 from other forms. In this connexion, it is noteworthy that the *B.M.J.*, in 1950, estimated that 10 per cent. of schools (but not of children) received raw milk.

In the last three and a half years, Wallace has isolated 1,600 strains of myco-tuberculosis in Edinburgh. Only one strain was bovine. This percentage is encouragingly low but the cases were almost entirely pulmonary.

Bovine Pulmonary Tuberculosis in Man.

As shown in Table IV, pulmonary tuberculosis in man is but rarely due to the bovine strain of bacillus. In 1928, Griffith isolated the bovine bacillus in 1.4 per cent. of 1,101 cases. During the years 1936-39 Hedvall, in co-operation with a veterinary surgeon, set out to detect such cases in the province of Skane, Sweden. From a population of 773,363 persons (326,338 urban and 447,025 rural) he discovered 67 cases and calculated that 3 per cent. of pulmonary tuberculosis in that area was due to the bovine strain of bacillus. In 1945 Sigurdsson reported the examination of 566 strains of tubercle bacilli from pulmonary cases and found 91 bovine, that is 16 per cent.

Hedvall's cases show that there is no sex difference (33 male, 34 female). The age incidence is distributed evenly up to the age of 42, after which the frequency decreases. The majority of the patients were over 15 years. Cases of meningitis, miliary and peritoneal tuberculosis were exclusively in children. Nearly all pulmonary, pleural and urogenital disease occurred in adults.

The occupational incidence is marked. Forty-three cases occurred in veterinarians, butchers, farmers, cowmen, farm servants, farm labourers or members of their households. Twenty-four cases were in other occupations. Only 14 of the cases lived in urban areas and this fact is no doubt connected with the type of milk consumed.

The following analysis of Hedvall and Sigurdsson's evidence suggests that pulmonary infection was often not due to ingestion of infected milk but to inhalation of infected droplets.

(i) The clinical features of disease were often those of typical primary pulmonary tuberculosis.

(ii) Most young children who drank from infected milk and who were not exposed to cattle did not develop disease.

(iii) Adults similarly exposed to infected milk developed human strain tuberculosis.

(iv) In these pulmonary cases there was not the same age distribution as in non-pulmonary disease —there was in fact an even age distribution up to 42 years and three cases over 60 developed disease.

Decreasing Morbidity due to Bovine Bacilli in Milk.

The following is evidence in favour of reduction of disease due to the bovine bacillus.

(i) Abdominal tuberculosis death rate in 1911 was 70 per 100,000 and in 1948 only 1.2.

(ii) It is generally agreed that a high proportion of deaths under five are due to the bovine bacillus. Table V, compiled by Crofton, compares 1921 with 1944. The latter year is prior to the widespread use of antibacterial drugs. The improved position in the London area is striking and probably due to pasteurisation of milk.

TABLE V

PROBABLE EFFECT OF PASTEURISATION OF MILK IN LONDON

(CROFTON, 1954)

Locality	Deaths from tuberculosis per 1,000,000 children under five years of age				
	1921		1944		Ratio, death rate 1944/21
	Deaths per 1,000,000	Total	Deaths per 1,000,000	Total	
London	136	51	6	1	0·044
Combined rural areas	252	176	60	37	0·238

(iii) The 1948 Prophit Survey analysed tuberculin reactions in children and adolescents. This was followed in 1949-50 by the National Tuberculin Survey. The latter revealed that for similar age groups, the tuberculosis conversion rate appreciably had fallen. There had been little improvement in human tuberculosis case finding or isolation and it is suggested that this fall is probably due to the extension of clean milk schemes.

The relation between the conversion rate in rural and urban districts suggests that tubercle bacilli in milk still play an important rôle. The 1949-50 report shows that one in five of school entrants in rural areas are tuberculin positive as compared wih one in ten urban entrants.

Warwickshire Milk.

Laboratory facilities limit the number of milk samples biologically tested. In Warwickshire approximately 1,000 samples are examined for tubercle bacilli each year. Positive results were 2.3 per cent. in 1950, 5.1 per cent. in 1952 and 3.8 per cent. in 1955. Thirty-five cattle were slaughtered in 1955 in the county under the Tuberculosis Orders. Of these, 26 followed herd examination as a result of milk reported to contain tubercle bacilli.

TABLE VI

EXAMINATION OF MILK SUPPLY IN CASES OF NOTIFIED NON-RESPIRATORY TUBERCULOSIS IN WARWICKSHIRE

Year	Number of non-respiratory cases	Number of cases in which milk supply found to contain tubercle bacilli	% Possible correlation
1952	88	14	16
1953	54	7	13
1954	75	8	11
1955	27	3	11
Total	244	32	13
Raw milk samples, 1955		474	3·8

As much non-respiratory tuberculosis is due to the bovine strain, it is reasonable to examine the milk supplied to such cases. In 1951, the Warwickshire County Council introduced a scheme. The results are shown in Table VI.

The County Council does not supply milk to school children unless it is either pasteurised or from a tuberculin tested herd.

Further evidence of the influence of milk containing tubercle bacilli is suggested by the figures in Table VII. These were obtained in 1955 by Bramwell at Stratford on Avon. Eleven hundred school children between the ages of 11 to 15 were tuberculin tested and the designation of home milk supply recorded. These figures, though suggestive, are not conclusive; it is, however, a line of investigation which might usefully be extended.

TABLE VII

INVESTIGATION OF MILK SUPPLIED TO POSITIVE TUBERCULIN REACTORS, STRATFORD UPON AVON

Type of milk supplied	Number of children tested	Number positive	% Positive
Pasteurised ...	914	349	38·4
Non-pasteurised :			
T.T.	68	30	44·3
Non-designated	118	61	51.5
Totals	1,100	440	40

Despite the evidence above the position in Warwickshire is probably improving. In 1949 there were 289 (13 per cent.) licensed tuberculin tested milk producers. At the end of February 1956 there were 932 (45 per cent.) licensed producers, which represents approximately 60 per cent. of milk supplied. It is calculated that 82 per cent. of the Warwickshire population now drink milk from a Specified Area.

I am grateful to the Chief Veterinary Officer of the Ministry of Agriculture and Fisheries for information that 90 per cent. of milk sold for liquid consumption in England and Wales is heat treated. As a result of notifications of infected milk 480 cows were slaughtered in England and Wales in 1955. Under the 1938 Tuberculosis Order, 1,251 cows were slaughtered; 47 per cent. of these had advanced tuberculosis. Under the 1950 Tuberculosis Order, 10,842 tuberculin reactors were slaughtered in 1955.

To appreciate fully the present impact of tuberculosis upon the economy of the country, one must add that 7,897 persons died from tuberculosis in 1954 and that over 200 of these deaths were probably due to the bovine strain of bacillus.

Infection of Cattle by the Human Strain of Bacillus

In 1936, Plum fed healthy cattle with human sputum containing tubercle bacilli. Tuberculin reactions were invariably produced, sometimes they were large and differentiation by avian and bovine tuberculins was not always easy. Macroscopical lesions were infrequently produced and those demonstrated were small in size. Nielson & Plum (1940)

reported only two instances of macroscopic disease caused by the human bacillus—one in a mesenteric gland and the second in a retropharyngeal gland.

McKinstey & Blamfield (1955) reported six instances of human cases of tuberculosis in Jersey producing tuberculin conversion in previously negative herds. One hundred cattle were exposed, 50 became reactors and of these 19 were slaughtered and examined *post-mortem;* none had a macroscopic tuberculous lesion.

Neilson & Plum (1940) reported 17 human cases to whom cattle were exposed. There were 397 reactors amongst 632 cattle. McKinstey defined the tuberculin reversion rate as 27 per cent. in three months, 39 per cent. in six months and 42 per cent. in 12 months.

Epidemiological Aspects as Between Man and Beast

Tuberculosis is commonly contracted by inhalation, sometimes and very occasionally by local inoculation. The general trend of tuberculosis incidence is to diminish.

In both man and other animals this trend is influenced by better housing and sanitary conditions, higher standard of living, earlier diagnosis, segregation or elimination of advanced cases and, in man, the development of immunity.

Tuberculosis in cats is usually due to the bovine strain and probably is of occasional importance in dairy hygiene and, rarely, in household hygiene.

Lovell & White state that the dog is probably equally susceptible to either the bovine or human strain and probably is of occcasional importance in & White in 3 of their 22 cases. In 1929 Smythe reported contact in 4 of 20 cases and Stableforth in 6 of 16 cases. Les Bouyries (1926) reported 10 Parisian dogs with disease; 8 lived in a cafe or restaurant.

Infection from man to dog appears to be established and from dog to man theoretically possible by infected droplets or dust inhalation from sputum or urine. Whilst human disease remains common, animals should be banned from public eating establishments.

Pigs are susceptible to the human strain and avian strains of bacillus. In the United States much trouble has been caused by infection of cattle with the avian strain which is prolific in chickens and other farmyard birds.

It is clear that cross infection between animals will be reduced by segregation of species from each other and by resting land areas to allow residual bacilli lodged in soil to die.

The influence of human tuberculosis upon cattle is occasionally important but its degree is uncertain. Clearly it should be appreciated and routine chest radiography of all farm workers associated with breeding or milking stock seems desirable. The experience of Sigurdsson suggests that further strain typing of tubercle bacilli in pulmonary tuberculosis is required. Veterinary inspection of cattle associated with a human case of pulmonary tuberculosis, should be routine. Medical inspection of farm workers associated with infected cattle should also be routine. One in five of human genito-urinary cases of tuberculosis is due to the bovine strain. Can it be pretended that the farmyard is used as a urinal exclusively by cattle?

Mycoses—Superficial and Deep

Like the poor, these are always with us. They seem to pay little regard to the times and the seasons. We encounter a steady dribble of cases. In most instances the diagnosis of a fungus infection is the reverse procedure of a bacteriological one. That is to say that if one can demonstrate fungus particles in fresh material that will be worth culturing.

Most of the cases we see are of the superficial group and of these the most usual is *T. discoides* which you meet as ringworm of cattle. It is an occupational hazard of veterinary surgeons. We seldom see classical ringworm of the scalp now. We are informed that school medical officers seldom use Wood's lamp nowadays. Infection with *M. audouini* and *M. canis* giving rise to human cases has been traced to a variety of pets and even to a pet hedgehog. The work of La Touche in Leeds which embraced both human and animal cases has shown a decrease in infection by *M. canis*.

Moniliasis. Various strains of *Candida* can be isolated as a normal commensal from man and animals. *C. albicans* is the only proven species pathogenic to both. Epidemics of moniliasis occur in certain situations. Oral thrush and systemic moniliasis tend to occur in infants and old age. *Candida* can often be isolated in profusion from patients receiving massive antibiotic treatment. Pruritis in diabetes is almost always due to *monilia*. Certain skin conditions are associated with its presence and in particular a paronychia.

Visceral Mycoses. Here the most common form that we see in this country is a pulmonary mycetoma most often associated with *Aspergillus fumigatus*. This infection usually follows on a pre-existing lesion of the lung from any one of a variety of causes.

Certain of the other visceral mycoses are said to occur in this country but so far we have not recognised them in South Warwickshire.

Facilities for diagnosis of ringworm infections are now being offered by the Public Health Laboratory Service as well as many regional hospital laboratories both to veterinary surgeons and doctors. The Mycological Reference Laboratory at the London School of Hygiene and the Ministry of Agriculture and Fisheries at Weybridge are accumulating valuable information and are immensely useful to pathologists in deciding difficult questions of mycology.

Histoplasmosis

Epidemiology.

In the United States of America histoplasmosis is prevalent in man and occasionally occurs in animals. In England the situation is different but two or three human cases are reported each year. Many of these have visited and probably become infected in the United States.

Epidemics of histoplasmosis have been associated with recovery of the fungus from various sources,

such as pigeon manure, cave and basement floors, sawdust, hollow trees and farm dust.

The organism has also been recovered from the atmosphere in a quantity equal to the inhalation of 100 spores, per adult, per day of normal activity.

Histoplasmosis, as coccidioidomycosis, is a common cause of pulmonary calcification in man. However, the organism may invade any part of the reticulo-endothelial system. It is only recently that epidemics of histoplasmosis have been recognised. The following is an example described by Loosli, Grayston, Alexander & Tanzi (1952).

Farm Epidemic.

There were eight residents on a farm. Dust from a silo was cleared out by the father, aged 49, with two of his sons, ages 21 and 5.

Ten days later, the three became ill with moderate pyrexia, cough, loss of weight and " burning chest pain." All chest radiographs revealed abnormal opacities. The father was gravely ill for four weeks. He developed thrombo-phlebitis of the left leg, severe respiratory embarrassment, pleural pain and high fever. His sputum and sternal marrow contained fungi. Liver biopsy revealed granulomatous lesions. The family were histoplasmin positive except mother and daughter-in-law who had not visited the silo.

Dust from the silo was cultured and the organism was grown from 50 per cent. of samples from a ledge and from 10 per cent. of samples from floor dust.

Some rabbits, two cats and a dog on the farm were histoplasmin negative; these were sacrificed, no abnormal histology was seen.

Prior & Saslow (1954) produced experimental histoplasmosis in dogs. In the same year Manges, Furculow & Hinton examined a number of sick animals and cultured the fungus in the following cases:—

ANIMAL HISTOPLASMOSIS
(Manges, Furculow, & Hinton, 1954)

Animal	Number examined	H. Caps cultured
Racoon ...	4	4
Dog ...	18	9
Cat ...	7	1
Skunk ...	7	1
Rat ...	545	3
Birds ...	80	0

Five dogs and the one cat were associated with human infection. The fungus thrives in soil and is probably disseminated by air and flood water. Case to case infection, theoretically possible, is unknown, but transference of the fungus from country to country is an important possibility and the following germane. A recent histoplasmin survey by Katayama and others (1952) of Japanese factory personnel found negative results except in three factories where 15.4 per cent. of workers were positive. These factories manufactured plate glass, insulating materials and chinaware—they imported soil and sand: mainly from the U.S.A.

Virus and Rickettsial Diseases

The relationship of virus and rickettsial diseases to animals and man is a special one and merits special comment. Our main interest in this country will be in the virus diseases, and of these, members of the lymphogranuloma-psittacosis group are probably of the greatest economic importance to man and to the country quite apart from their scientific interest. We can include the virus of epidemic influenza in this group and for the sake of convenience the common cold also. Apart from these two diseases there is a number of others of less financial account to the community which may occur in epidemic form in both man and animals.

The development of overt psittacosis in birds seems to be associated in some way with environmental change. Possibly the non-specific factors influencing immunity are in some measure upset and clinical disease develops. In man the disease is a fascinating clinical problem. There have been several deaths from it in this country.

When animals harbour *R. burneti* there usually does not appear to be any ill effect, not even a reduction in milk production in herds of affected cows. Evidence of infection of cows has now been found in England and Wales and some parts of Scotland. Human infection rates as estimated from blood donors usually vary between 0.5 to 3.0 per thousand.

Apart from the fascinating problems associated with this disease such viruses as those of foot-and-mouth disease and enzoötic abortion of ewes have given rise to cases of human infection and may give others in time to come. There is, of course, a host of other diseases including rabies, which has been recognised in human cases at least twice in this country within the past 12 months, louping-ill which usually occurs as a laboratory infection, and others of the encephalitis group where an insect vector may be concerned, lymphocytic choriomeningitis which is harboured by infected house-mice and " B " virus which has quite a distinguished list of victims in both the medical and political world. In fact the line stretches out to the crack of doom, and some there are that two-fold balls and triple sceptres carry.

The captain of the viruses is undoubtedly epidemic influenza. There is more than one type of virus. Outbreaks due to Virus A recur every two to three years; those due to Virus B recur every three to six years. Mixed outbreaks are sometimes observed and the changes in types and the variants which are now being met with serve to confuse the immunological issue.

Swine influenza was first recognised in the United States in 1918 in close association with the great human pandemic of influenza. The virus nature of human influenza was established by Smith, Andrewes & Laidlaw in 1933. Shope (1931) established that the swine disease was caused by the associated effects of a filterable virus and a haemophilic bacillus—*H. influenzæ suis*. It has been suggested and there seems to be good evidence for believing that the great pandemic was caused by the swine virus or one antigenically indistinguishable therefrom. But since the early '30's there has been considerable

work on the various sorts and types of influenza viruses and their related diseases. It would appear to be established that swine virus differs in important characters from human virus as we now know it. Further, *H. influenzæ* has not the same necessary importance in human cases as *H. influenzæ suis* has in swine cases. The inference is that the two diseases are not caused by the same agent or agents.

There is no information indicating that virus pneumonias of calves or pigs are related to human diseases. There is as yet no definite evidence showing the same virus responsible for cat distemper and associated cases of human pneumonia. We can find no evidence of human infection with classical distemper. In fact there is a list of problems sufficient to keep virus workers busy for years to come. It would be possible to prolong the tale of negative information *ad infinitum*.

Jaagsiekte

This is a disease of the respiratory system of sheep and is characterised by massive pulmonary consolidation of a special type. It is stated to be infectious and experimental transmission has been demonstrated. Its presence has been reported in South Africa, in Germany, in Scandinavia and in Iceland. No reports of its occurrence in this country have occurred as far as we are aware.

It is said to present a special type of microscopical picture. There is an inflammatory exudate, sometimes lymphoid hyperplasia and an overgrowth of epithelium in bronchioles and following the alveolar pattern. This overgrowth has been said to give the pattern of a bronchial adenoma. It appears that the cells are columnar and non-ciliate. They have been said to arise from the "alveolar epithelium," but in our opinion there is a doubt about this.

From all we have read about jaagsiekte it appears to be a disease *sui generis*. We do not understand the strict species specificity of reported cases. Experiments to transmit it to other domestic animals and to smaller laboratory animals have not been marked with success.

Our interest in this connexion is that there occurs in humans a disease which is likened to jaagsiekte particularly on microscopical grounds. It goes under a number of aliases, of which pulmonary adenomatosis and terminal bronchiolar cell carcinoma are the best known. It shows a proliferation of columnar epithelial cells which are non-ciliate and which often show a mucinous vacuole. This proliferation follows the basic framework of the lung and alveoli. There has been great argument as to the histogenesis of these cells. We favour the theory of their origin in the terminal bronchioles. We have four cases in our files which we accept as belonging to this category. Similar cases have been reported in humans elsewhere in this country. Quite a number has occurred in the U.S.A. and at least one has been reported from Java. They form a group which is histologically distinct from the ordinary run of lung tumours and as such attract attention. Although the histological similarity of the human cases to those reported in sheep has been frequently commented upon we have seen no reports of association of these cases with sheep or rats. Nor has anyone suggested an increase or prevalence among sheep in areas where human cases have arisen. The whole matter is wide open for a research project arising out of routine problems.

Porphyria

Porphyria is an inborn error of metabolism. It is characterised by passage of abnormal pigments in the urine and by various visceral manifestations. The signs and symptoms are protean. The disease may go undiagnosed for many years wherein the patient drags miserably from doctor to specialist and back again. Very often it is only spotted when a colour change is noticed in a sample of urine that has been kept overnight. Special biochemical tests may reveal the presence of abnormal pigments before this colour change takes place.

The patients present a variety of symptoms. Abdominal pain is a common one and many a patient has lost an appendix or gall bladder in an attempt to alleviate this. Symptoms referable to the central nervous system such as various pareses or paralyses again may be the cause of presentation or may follow the painful symptoms in certain events.

The disease may be a familial one and may be inherited in the pattern of a Mendelian dominant. If individuals manage to survive to middle life they usually escape the more drastic and killing sequelae and complications. In woman in early life pregnancy is particularly dangerous, but later on this may be gone through albeit with some trepidation on the part of the medical attendants.

Barbiturates also are considered as dangerous and liable either to produce or to enhance an acute attack. Thus certain sedatives and anaesthetics must be avoided in affected individuals.

It is thought that the disease is essentially Scandinavian in origin. Thus the highest proportion of cases in England is to be found on the east coast where the Norse invaders have left it as a legacy. It has spread across the country and in this area we have several families affected.

The importance of studying the disease whenever possible lies in our lack of knowledge of its pathological physiology. We do not really know where in the body the pigment is formed and how acute signs and symptoms are produced either by it or with it. We do not know the real relation of acute manifestations to the strain and stresses of adult life, pregnancy and such-like, and the particular relationship played by barbiturates is still a matter of speculation.

In the U.S.A. the disease has been described in the fox squirrel and in Denmark it has been described in pigs and cattle. It would appear that the disease is recognised in these animals by the colour of teeth and bones at the time of slaughtering. But it has been noticed in individual members of a herd at the time of veterinary inspection.

The importance of drawing this matter to your attention is the general paucity of information about the disease in humans. It can be produced in animals under certain conditions but a naturally occurring incidence in a reasonable-sized domestic animal is badly needed to undertake further studies.

Miscellaneous

We want to mention a few conditions for the sake of completeness.

We do not think that we could possibly conclude any such talk as this, however informal, without using the word hydatid. Actually we encounter a case about once in five years. We do not know who is to be commended for this but feel that it speaks well for the general hygienic measures.

We must include some general bacteriology. We have had one case of infection by *Salmonella cholera suis* in the past three years. This infection occurs sporadically in this country. As usual we were quite unable to trace the source.

Finally we would like to mention cat-scratch fever. This had quite a vogue some years ago. But in the past two or three years we have not encountered any likely candidates. Clinical pathologists used to suspect the condition from the histological appearances of lymph nodes. A diagnostic antigen was made from a sufferer in another part of the country and an intradermal test used.

It seems to us that the veterinary profession should be a very fruitful source of clinical material of this ill-understood condition.

Summary

We have given an account of diseases affecting both men and animals as we have seen them in South Warwickshire. We have discussed clinical and epidemiological features of some of these; in particular we would emphasise the wisdom of routine chest radiography of those who work with farm animals.

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THE SPEAKERS' INTRODUCTION

The Chairman (Mr. E. R. Corrigall), in opening the session, extended a warm welcome to members of the Leamington Medical Society who were present.

Dr. A. P. Prior said: "It has been an interesting task to try to prepare a paper for this Congress and we would like to illustrate some of the points. When we looked through our material on brucellosis we realised that although population surveys both in this country and to some extent in the United States did contain a number of veterinary subjects, a complete survey, certainly in this country, had not been devoted to veterinary surgeons only, and we have taken this opportunity of paying some attention to this point. With the assistance of the veterinary surgeons of Warwickshire, out of a total veterinary population of approximately 50, not less than 18 volunteered for experiments and they have suffered nobly in your cause; 17 of the 18 had positive stain tests but the serological response was not impressive.

"We did brucellin skin tests on these gentlemen and one lady and took serum on the first occasion and then at two weeks and four weeks. The first one had a most impressive skin reaction; he had a most impressive ulcer a fortnight later and he was the only one of the series who produced anything in the nature of the expected response. Some got a small titre of hardly any significance as much as four weeks later; of the 18 tested, 17 gave quite adequate skin response, but the man from the Ministry was unable to give an answer within 48 hours. My colleague will discuss this in more detail.

"The slide illustrates the culture of *Aspergillus* which was isolated from a pulmonary lesion in a woman patient. The next is orf which is contagious pustular dermatitis of sheep with its characteristic vesicles on the skin. We had a small epidemic of this condition earlier this year in the Stratford area. The importance of this to the medical man is to leave it alone until it gets better.

"The next slide is taken from one of Dingaal's papers on Jaagsiekte and this is the lesion as it occurs in sheep. It is roughly an alveolar arrangement and is made up of tall columnar cells.

"The next slide illustrates the analogous condition described and seen in the human, again an alveolar arrangement of tall columnar cells."

Dr. P. G. Arblaster: "As often happens things get mixed up; I was supposed to go into the brucellosis results. Dr. Prior has given you the fact that 17 out of 18 tested had a positive brucellin result, and he has also given you the agglutination results. We thought we should extend this investigation to a number of controls, so we tested 20 consecutive admissions to Stratford hospital and only three were positive. Very much as an afterthought (it was unexpectedly fruitful), we decided to go into the past histories of the veterinary surgeons with the positive test. With summer holidays and so forth we were only able to question eight closely, but of these eight, six admitted to symptoms suggestive, though not conclusive of chronic brucellosis. All of the six had had headaches which occurred in the frontal or occipital region and which lasted

for four to six hours occurring up to five or six times a year. Three of the six complained of lassitude and debility. Pyrexia and sweating was complained of by another three, and a further two admitted to aches and pains in various parts of the body. One admitted to symptoms which had occurred over the last 20 years and a second one of chronic ill health over a period of 10 years.

"What are our conclusions from this? The first and most obvious point is that further investigation is clearly indicated. We know, for instance, very little of the significance of the various diagnostic criteria. Possibly the most reliable test is the liver biopsy to which we did not submit your colleagues. We wish to know what sections of the community are affected, urban and rural, etc. I do not think we know very much about the mode of infection: some say it is by local inoculation, some by ingestion, others by inhalation. Those of you who may be slipping to a silent somnolent state may have chronic brucellosis, and that brings me to the last and perhaps most important point about brucellosis and it is that at the present day we neither know the place of treatment in this condition nor do we know the effective therapeutic regime.

"The next slide takes us on to the rare but fascinating disease histoplasmosis and it shows the causative organism. We will draw your attention to its well-marked capsule. Cases of this disease have been described in all parts of the world, but I would like to stress that in fact it is extremely rare outside the United States. In the British Isles one or two cases a year are described. In the United States the incidence is notably high in the Mississippi Valley, and in that area between 70 and 90 per cent. of young adults have a positive reaction to histoplasmin—a skin test which is similar to brucellin and tuberculin.

"The type of disease caused by this fungus is either a generalised infection of the reticulo-endothelial system, and this is the form which commonly occurs in animals, or it may be localised, occurring in the lungs of human beings and producing symptoms indistinguishable from those of pulmonary tuberculosis.

"This slide is one of a patient with extensive pulmonary histoplasmosis, the end result of which is either complete clearing or extensive and deep calcification involving many areas of the lungs. You will also notice that there are specialities around the heart, the hila layers are involved and intensely calcified. You may ask why we mention this disease. Firstly, it is rather fascinating, and secondly, human cases have in five instances been associated with animal diseases, in four instances the dog and in one the cat. Thirdly, there is recent evidence from Japan where histoplasmic reactions are negative except in a number of factory workers who used imported wool from the United States. I think, therefore, that it is reasonable that both our professions should keep our eyes open for the possibility of early cases in either man or animal."

Dr. Prior: "This is actually a section of the histoplasma as it occurs in experimental animals, intracellularly. The next is a picture of the haemoglobin molecule from which by breaking down the cell we get porphyrin. The passage of this dye in the urine is characteristic of the disease porphyria, and gives to the samples of urine this characteristic colour. It is seen in patients with paresis and paralysis. One boy, in the intervals between attacks, could move his arms perfectly readily, whereas during his attacks his movement was entirely and grossly limited."

Dr. Arblaster: "In our paper we have given fairly comprehensive evidence of the role of the bovine strain of *Mycobacterium tuberculosis* in both human beings and animals, and I thought you might be interested to let me put this in perspective by telling you something about the present figures and trends in human tuberculosis.

"The first slide is a graph showing the mortality rate over the last hundred years, 1850 to 1950, which shows a steady and quite considerable fall. This fall is largely due to increased resistance in the host and not to decreased virulence of the infecting organism. Recently there has been a fall in both respiratory and non-respiratory disease. The majority of the infections nowadays occur in the male between 45 and 55, and the majority of the notifications in the female are in the age group 15 to 34. This association between young men and women of a certain age has been unexplained by the medical profession but I feel, perhaps, we have lost what might have been a great opportunity had the matter been referred to the late Dr. Kinsey. As would be expected, this particular age-sex structure is reflected in the mortality rate from tuberculosis. The majority of the females die in the young age groups and the males die in the 50-70 and on occasion in the 80's. Table II in the paper shows the occurrence in different animals of the various strains of tubercle bacilli. It will be seen that the pig, the dog and man are susceptible mainly to the human strain, whereas cattle, horses, sheep, cats and dogs are more susceptible to the bovine strain of bacillus.

"I recently received the organs of a cat. I realised there was something unusual about them because they came in a little tin. You will see from the slide that the liver is studded with large masses of what in fact was caseous material; the section showed that the lesions extended throughout its depth. There is some normal tissue but there is no evidence of cellular reaction in the form of epithelial cells or giant cells. As a public health problem we thought that we should examine the human contacts of this cat, and we X-rayed 30 adults and children who were all normal. We went into the milk supply and it appeared to be free of tubercle bacilli. I think there is a field here for close co-operation between the two professions. Our main aim is to identify the source of infection."

The Openers

Dr. N. S. Barron, opening the discussion, said: "I must say that when I first received a copy of the authors' paper for observation I felt sad because I observed that tuberculosis occupied almost half of the entire script. I felt we had not progressed very much. I can look back to 20 years of papers on the same subject suggesting tuberculosis was the be-all and end-all of this intriguing problem of the influence of animal diseases on the human community. We have progressed of course and the heading '*Mycobacterium*' gives a definite step in the right direction! Further observation, however, revealed that the paper included a number of very interesting subjects. This paper does not cover a wide area of the country but is a review of the authors' experience in a community. If we reviewed the entire country the picture would undoubtedly be otherwise and bring in a good many additional diseases. It did, however, seem to me that there were a number of deficiencies.

"Before I leave the tuberculosis aspect, which will be dealt with adequately by my other colleagues, it is of interest to observe the reference to the dog, and I take it that, in due course, canines will get together and boycott all restaurants where human beings go to get a cup of tea! I think perhaps the reference to tetanus in this paper was a little unkind, or have we not yet realised that tetanus is widespread not only amongst horses but frequently cases occur in sheep and also in pigs. Thus the reference to horses in particular, and the need for immunising those children who ride is perhaps misplaced. I feel this disease hardly merits a place in this paper. It is hardly fair to blame the animal for it. Is it not a question of contact with the soil rather than the animal?

"I suppose we must expect a changing picture in such a story as this when we look round and see the marked changes taking place in husbandry in every field of our work. In particular, do we notice a greater concentration of animals, and the greater risk therefore, of spreading disease to those who handle them, apart from the risks to the animals themselves? There are enormous changes in the poultry industry where both hens and turkeys are kept in greater concentration than ever before. We may well expect more cases of salmonellosis and psittacosis—the latter especially from turkeys. I wonder why there was only a brief reference to diseases of this group in the last section of the paper? Is it that such things are being overlooked or that the human population has an un-

expected degree of resistance to organisms of this sort? *Salmonella* are recorded very frequently in birds, in pigs and in cattle and yet we do not hear often of human cases except when someone has eaten a trifle or some sort of meat paste.

"The problem of brucellosis was included in the paper but the method of infection is still an intriguing question for further investigation. I was interested in the Table shown by one of the speakers which indicated how many veterinary surgeons in this country reacted to the skin test. In 1935 some 119 veterinary surgeons submitted themselves to a blood test at Folkestone and it was amazing how few showed any reaction whatever. I do not believe that the observations were ever published, but I remember that about four showed an appreciable reaction and one showed a very high titre. Veterinarians as a group are surely more 'at risk' than any other single section of the community and even by existing tests should show some sort of infection. To me the issue is confused when clearly the authors say 'we have not got suitable tests for spotting people who are infected.' Perhaps they would clarify this point.

"In the paper, reference is made to diseases due to fungi. I think we are going to find that this sphere of research will enlarge greatly and many diseases which we have not hitherto suspected are associated with fungi of one sort or another. I would like to know more from our medical colleagues about the impact of the various diseases to which they refer—why it is that we have this interplay of disease between animals—calves, pigs, and so forth? I wonder whether, as a result of the distribution of that composite group of diseases now known as virus pneumonia in pigs, more of us will become subject to chest diseases in the future than has been the case in the past?

"I would like to congratulate the authors in particular on the racy style of the paper. It made their thesis much more readable for busy people than if it had been written in a heavy scientific form. The work that they and others are doing is bound to benefit the medical profession in particular in enabling them to make more correct diagnoses, and we shall have fewer faulty surveys in the future. It also encourages us to appreciate the end results of our work. The tendency is to see our work in terms of what the farmer can get out of the animals rather than see a little further and appreciate how much value we can be to our fellow human beings by reducing and eradicating human diseases which may be dangerous to ourselves as well as to our animals."

Mr. H. T. Matthews: "It is always interesting to hear the other chap's point of view and the authors this morning have given us theirs. They have produced a miscellany of so-called animal diseases. Some of us find it perhaps a little queer. I hasten to say that this is not an adverse criticism, it is just a comment, and I suggest some of it has been forced upon them by the unfortunate wording of the title. In fact, I think the title is thoroughly bad. There is an implied distinction between man and the other animals. It is valid on the psychological plane but in physical matters it is artificial. Man is one of the animals and shares many of their diseases, particularly in relation to the infections. There is no effective barrier between the other animals and man as there seems to be between plant and animal life. One could cite many examples to illustrate that. Let us consider the *Salmonella* group.

"I understand that the bacteriology of human paratyphoid changed substantially when we imported spray-dried eggs from Americt. Now do we allocate the *Salmonella* to poultry or to man, or perhaps to rodents? *Typhi-murium* and other types are not a bit concerned about what kind of host they infect and man takes his place in the group as just one of the animals. The leptospira: I suppose the medical officer of health instinctively thinks of leptospira in terms of rats, and we of dogs, but we know that the various leptospirae are catholic, that they have been found in many kinds of animal other than rats and dogs and that is just another example of the versatility of so many of the infecting bacteria. What we can be certain of is that the list of so-called communicable diseases drawn up by the World Health Organisation and other authorities is far from complete.

"Meyer of California recently wrote that 'if the parasite is versatile it can find a suitable host among any of a large number of animals. It is almost unquestionable that sooner or later human beings will contract the disease it causes.' That is, perhaps, an extreme and rather gloomy view but it does emphasise the point which I am making—that man simply takes his place as one of the susceptible animals.

"It also introduces my second objection to the wording of this title, namely, the 'point of view.' I suppose we can translate the laws of nature into terms of the micro-organisms as we do in relation to the larger ones. If so, the emphasis is on posterity and we can say that a successful organism is one which ensures its posterity. Perhaps our common use of the term 'natural host' in relation to parasites is unfortunate and it may be that the natural host is represented more correctly by the cow infected with the rickettsia of a fever or *Br. melitensis* where the organism has found food and lodging and has little need to pass on to other animals, including man, by causing disease. There is a tolerance between the organism and the host, and if we look at this not from the medical angle nor the veterinary angle but from the viewpoint of the parasite there is success in the parasitic field in that it has found a host which will not react violently, as is manifested by illness, nor die too quickly so that the sequence is broken. There is little doubt that a great many of the organisms which we call parasitic are harbouring in many kinds of animals unknown to us. It might not be the state of harmony which is symbiosis but there is little or no conflict between the host and the parasite.

"We, with our ability to slaughter our patients, which the doctors are unfortunately not permitted to do with such facility, naturally think in terms of eradication of a disease or of a parasite, but it may be that we are now in the age where we shall have to consider in terms of major policy, the promotion of a state of tolerance or a mild response rather than attempts to eradicate. That is perhaps illustrated to us in terms of coccidium and some of the nematodes.

"With that preamble, it will not be surprising if, like Dr. Barron, I take exception to the inclusion of tetanus in this list provided for us to-day. Tetanus is an organism widely and unevenly distributed in the soil of this and many other countries; occasionally it passes through the intestinal tract of many kinds of animal including the horse, illness only following a wound; but from the angle of the organism itself it appears that the illness caused is quite accidental. There is no good purpose served to the organism in creating a state of disease. I think that we, handling a clinical case of tetanus, are in no more danger than we are when, for example, gardening, and perhaps less, so I suggest that the answer to the question in the paper is that we do not consider ourselves particularly exposed and we see no good reason to take special preventive precautions.

"Histoplasma is an organism which is also widespread in the soil of some places. I understand that we have only had a few cases in this country, but I was a little upset to hear the opener use the phrase 'the offending animal' in relation to it. I do not quite take that as a sound view of the epidemiology of histoplasmosis if we find it becomes important in human beings in this country. There is an interesting recent observation (Beverley *et al.*, 1954) with that quite unrelated organism toxoplasma, the protozoon, with a very doubtful life history, where it has been reported that 25 per cent. of the tested human population of Sheffield showed serum antibodies against this protozoon with a bias to veterinary surgeons and abattoir workers. Illness is not apparent, but it is an interesting observation and it may well be that that picture will be extended with more investigation.

"Leprosy: we are just not going to accept leprosy because by a bit of pathologist's juggling it has become implanted in some other animal than man. Man can have it. It is an example of one of the highly specific minority

organisms. It reminds us of the biologically related, though not quite so highly specific, Johne's organism which causes us many headaches. When the doctors produce us a case of clinical Johne's disease in man perhaps we would re-consider leprosy.

"The development of attestation has already made a contribution to human health in this country. It will become more evident in the next 10 to 15 years. There are already difficulties in America and elsewhere which indicate what we may expect in relation to human infection from the bovine type of TB. organism.

"Sigurdsson found that the bovine type behaves in the human lung in a manner which is clinically indistinguishable from that of the human type. People can pass the bovine type on to each other freely without the intervention of the cow. That might eventually prove rather a nuisance to us; I think a nuisance rather than a serious trouble, but it is not one which we can ignore and it may come up into prominence in the years when we are approaching eradication of bovine TB. from cattle. I think that our objective of eradication is attainable in this disease. Whether it is entirely sound is another problem but I think that we shall get there and in doing so we will make quite a contribution to human health.

"The widespread use of Strain 19 vaccine against *Br. abortus* has changed the farm picture in this country substantially. There is an interesting finding recently reported by Nielson (1956) of *Br. suis* in hares in Denmark. We are fortunately so far as we know free from *Br. suis* in this country and *Br. melitensis* does not seem to be of much public health significance although provision is made for eliminating it from cattle when it does turn up. The brucella group of organisms are very catholic in their taste and we shall run into trouble sooner or later if we decide to eradicate brucellosis from this country because of that catholicity of taste.

"Rabies in this country is a disease of the past; but that it is not generally so is evident from the stories of the disease travelling westwards from Germany during the past few years. The wild uncontrollable animals are a real problem in the control of this disease which, again, is caused by an extremely catholic virus which can infect any mammal including, of course, man. The kinds of animal involved in Europe and in other countries range widely among wolves and badgers, coyotes, and bats and they do present difficulties, but the virus itself is vulnerable. It relies entirely on a physical attack by a sick animal and has no other mechanism for continuity. I think, because of that feature, that there are more possibilities of a total eradication of rabies from the world than is the case with most of the parasites, bacterial, protozoon or whatever you like, but rabies does bring it to our notice that we have got to think internationally about disease of that kind.

"The fact that this paper has been given by doctors is an indication of a widening outlook which we welcome very much. I have spent my time in disagreeing and none of it on the politeness of agreeing, but we are, I am quite sure, very grateful to the authors."

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The General Discussion

Mr. K. D. Downham (Cirencester), said that he had one or two things he would like to say about this paper and again, if he was critical, he hoped it would be constructive and to some purpose. Years ago he had the chance and the interesting opportunity of working with agriculturists, veterinary surgeons and medical men in this area; they worked in Shropshire, Warwickshire and Staffordshire through the University of Birmingham and a regional Committee which consisted of the Vice-Chancellor of the University, the Professors of Biology, Bacteriology, Preventive Medicine and all the local veterinary surgeons engaged in any way in animal and health public. In addition there were many of the agriculturists who worked together. Unfortunately the war came and they did not go as far as they had hoped, as a matter of fact they did not get a great deal of support from the veterinary profession.

At that time they had such men as Matthews working with the medical profession; the School of Tropical Medicine in Liverpool included Noel, Pillows, who many members would know, and they had a local team working on local conditions with the medical men and the agriculturists in Lancashire and Cheshire. He thought they would get somewhere with that type of team. It might be thought that he was against the Animal Health Branch, he was aware that they were doing and had done a very good job but he would hate to be a whole-time public investigator. He had the chance once but did not accept it. They must have independent research with teams of workers not all under one control.

He could remember where in Shropshire 10,000 milk samples were taken every six months for examination for tubercle bacilli. In this paper it was said, with regard to tuberculosis, that 1,000 tests had been made for tubercle bacilli in Warwickshire and that there had been a percentage decrease instead of an increase. In Warwickshire there were some actual figures which seemed to be a little enlightening. There were positive results: 2.3 per cent. in 1950, and in 1955 3.8 per cent. positive results from milk samples. No one wanted to go backwards, just as he believed that at the Royal Agricultural College they had a far better idea 50 years ago with regard to the teaching of preventive medicine for agriculturists, because agriculture had been squeezing out the very valuable help which people like Hunting and George Wooldridge, Shearer and Duncan, were able to give. They were a small unit, and Sir George Brown, who started the animal health service and had worked for 12 years with agriculturists, was able to start the very good work which had been done by the Animal Health Division. He became veterinary adviser to the Privy Council.

He would refer to one or two things which were happening in this area. He had been trying to play tennis but he could not get anybody to play with him, so he decided he would play by himself. He went to the courts and practised serving for half an hour and then he was driven off the court by a cloud of the most foul atmospheric pollution which could occur anywhere from a local works. As they had one of their medical friends there that morning who was interested in trauma of the lungs he mentioned it because it might give him a valuable chance to do something about its possible cause right in the centre of Leamington Spa.

Recently there had been at the College many agriculturists from Yugoslavia. They were in this country for nine weeks and amongst them were veterinary people who said that they and the medical people worked closely together there, but the medical profession was annoyed with them because the veterinarians had more pay than the medical men. He asked why and the reply was that the veterinary profession was considered to be a dangerous profession, and they received special danger pay not received by the medical men.

The other point to which he wished to draw attention was the fact that there was a disease of fog fever in certain areas and that was one of the diseases which only a team of agriculturists, veterinary surgeons and medical men could profitably engage upon and do some valuable research together. He would also like to refer to the Holttum skin tests for brucellosis carried out in the 20's; it seemed to be a valuable test and it was a pity more of it was not still done. The influence of soil upon both the animals and man living upon it might profitably be studied in certain areas from an epidemiological point of view.

Mr. J. N. Ritchie (Chief Veterinary Officer) said he wanted to say something about tuberculosis as it was mentioned in the paper.

In the first place Table II which was shown on the screen when the paper was introduced was one which should be looked at critically. It seemed to him that it might be true of the samples which were taken but it had little bearing on the situation generally throughout the

country. For instance, he would be difficult to persuade that 118 out of 163 pigs with tuberculosis showed the human strain as being an indication of the situation in the country as a whole. He was quite sure that the Table was not meant to suggest that but it was suggested when the paper was introduced that it did indicate something of the susceptibility of the various animals to various strains of the organism. In cattle, for instance, a few cases of human strain tuberculosis had been recorded in the course of the *post-mortem* work which had been done on animals sensitive to tuberculin and in no instance did they ever find a case of progressive tuberculosis of that strain in cattle.

On the other hand, so far as pigs were concerned, it was quite a common finding that the avian strain of the organism did cause progressive disease. He simply wanted to mention that because he did feel that it might be misleading for some folk reading this Table if they did not read it critically.

He thought perhaps he must also emphasise that in using the allergic test for tuberculosis veterinarians used it differently from their medical colleagues. What they were endeavouring to do was to identify the animal which was affected with the bovine type of tuberculosis—the animal which was suffering from the disease of tuberculosis as compared with the animal sensitive to tuberculin—because of contact with another type of the organism altogether.

By the progress made in connexion with the eradication of bovine tuberculosis from the herds of this country the picture had been changed entirely from that of a number of years ago. Records of infection in cattle with organisms other than the bovine type were rare in an earlier day. This was understandable because, quite clearly, the herds were heavily infected with the organism which in fact caused disease amongst cattle and little attention needed to be paid to any other strain infecting them. However, it had been learned that while bovine infection had been removed from the herds so the other strains had become increasingly important, not because of introducing clinical disease among stock, but because of the influence upon the tuberculin test. That was the instrument for measuring whether or not an animal should remain in the herd and it would not be surprising if the incidence of other strains of infection amongst cattle in this country rose in proportion as the years went on.

One of the points which was of importance, and he was sure Dr. Barron would agree with him, was that 10 years ago if medical people had joined in their discussions they would have been urged to do something about bovine tuberculosis because so many children were succumbing to it in one way or another. The situation had changed in that the human being affected by the bovine type of organism was a possible source of active infection in tubercule-free herds of cattle and could in fact be responsible for serious breaks in tubercule freedom in such herds.

He thought it was of some little interest locally to mention that in this county of Warwick the number of animals slaughtered as clinical cases of bovine tuberculosis in 1936 was 325 and that figure had gradually been reduced through the years until in 1955 only 35 animals had to be slaughtered as clinical cases of tuberculosis. In 1938 there were 22 attested herds in Warwickshire and at the end of 1955 there were 1,199. He would suggest to Mr. Downham that the 1,199 herds which were attested were not being sampled for tuberculosis and that the percentage of 3.8 found in 1955 would relate to the herds which were not yet in that fortunate state.

Might he in general welcome a paper of this nature. If time allowed one would have liked to say a good deal more about it, not only about its omissions but also about a few of the inclusions which had already been commented on by previous speakers. He thought it was important to note in connexion with brucellosis the fact that generally speaking the organism we had to contend with in this country was *Br. abortus*, that the organism which seemed to be *Br. melitensis* had been encountered, but that there was no evidence of *Br. suis*. In many countries where brucellosis in the human population was really serious it arose to a large extent from *Br. melitensis* and in other countries from *Br. suis*. While it was of considerable interest to know the reactions to serological tests which might be found among the various classes of the community here, he would very much doubt if brucellosis in this country, especially with the efforts which were being made towards its control in the dairy herds would ever be a very serious public health problem. The eradication of brucellosis from cattle could however remove the only real source of infection to the human subject.

Mr. T. Barton Mann (Weyhill) said he had listened with a great deal of interest to the paper, and especially to the remarks made from the platform that there was a lack of mention of salmonellosis troubles. There had been a great deal of academic discussion and perhaps he might be forgiven if he brought the matter down to the practical. He had a great admiration for the medical profession; he had had occasion to seek help from the medical schools and laboratories when he had encountered difficult problems. This help had always been extended freely, often at great inconvenience, and he was very grateful for it. Nevertheless, there could be times when the veterinary view could come into conflict with the medical view and it behoved the veterinarian to adhere to his view if it was based on sound knowledge and experience of those diseases more common to animals than humans.

He had in mind a case of infection which had been transmitted from baby poults to their owner, his wife and an employee who, losing a number of poults, undertook a home *post-mortem* examination of some of the carcases with the result that all three humans were removed to hospital. Here an anaerogenic *S. typhi-murium* was isolated and diagnosed as the cause for hospitalisation. When the owner recovered and returned to take up his farming activities, pressure was put upon him by the Medical Officer of Health and the local Sanitary Authorities to divulge the whereabouts of the birds of his breeding flock which had been killed, sold and placed in cold store. He came to him for advice, informing him that "The M.O.H. and the Sanitary Authorities were badgering him for this information; if he supplied it he had a fear that the carcases would be condemned, he had sold them for nearly £3,000 and he feared he stood to lose this sum."

Enquiry elicited that he still had some broods of baby poults, hatched from eggs reserved after the killing and disposal of the parent stock and that these poults were still suffering heavy mortality. The speaker stated that in view of his experience with anaerogenic and aerogenic *S. pullorum*, when it had been experimentally shown by Hadley, Caldwell and Heath (1919, *J. Bact.*, **4**, 65) that anaerogenosis and aerogenosis depended entirely upon the type of nourishment offered to the microbe, and personal research (BARTON MANN, 1945, *J. Agric. Sci.*, **35**, Part 4, 218) elicited that suppression of gas was coupled with the presence of at least one other organism and that both organisms, growing together, tended to elevation of virulence, an examination was made of some of the dead poults. Of 13 examined all produced, from stabs of heart, liver and bone marrow, a growth of an anaerogenic *S. typhi-murium* and an enterococcus. To confirm, cultures were submitted to another laboratory which reported: *S. typhi-murium* anaerogenic and streptococcus, Lancefield Group D. Further enquiry showed that the diet offered to the poults was precisely the type which would fulminate latent salmonellosis to epidemic proportions; it contained an excessive quantity of fish meal and bran and was deficient in carbohydrate. It was clear that no epidemic salmonellosis had occurred in the adult stock, for they had been accepted by a buyer who would have refused dead or dying birds and the late owner assured him that the adult stock had not suffered losses prior to killing. He advised his client not to divulge the information required by the M.O.H. and the Sanitary Authority.

It was a clear case of wrongful dietary conditions applied to the poults, fulminating salmonellosis to epidemic proportions, the first phase being excessive proliferation by the diet offered, the second phase being an increase of virulence by passage. The organism may have been transmitted by one or more of the adult birds but the

evidence of lack of dead or dying or of any epidemic pointed to the non-pathogenicity of the organism in the parent stock. The speaker thought that if all poultry and pigs suspected of harbouring salmonellae are to be subject to condemnation, or the threat of condemnation by the medical profession *via* the Sanitary Authority, and without promise of compensation, then poultry and pig rearing in this country would cease to exist. He had not heard of any fresh case of anaerogenic typhi-murium infection of humans as the result of his advice and it was reasonable to believe that the £3,000 worth of turkeys had been eaten long ago.

Of course, it might be argued that he had given wrongful advice, but he was bound to take into account the fact that he had known of many cases of typhi-murium infection in poults, very often leading to great mortality; he had seen it ignored by farm staff in the matter of handling casualties and infected brooders; he had many years' laboratory experience during which he and his staff had handled hundreds of cultures of salmonellae which they had recovered from all sorts of outbreaks and he had never had a case of transmission of salmonellae from stock or from cultures to any human being under his charge. Maybe this was because he knew that anaerogenic salmonellae are dangerous, for anaerogenic properties, virulence and wrongful feeding of stock go hand in hand. Aerogenic salmonellae were not unduly pathogenic and only became pathogenic when dietary conditions stimulated excessive proliferation by way of residues of indigestion and by way of the symbiotic or synergistic action of accompanying bacteria in the gut, and finally, when passage increased virulence. Under such circumstances, if *S. pullorum* was a criterion, they tended to become anaerogenic.

One other thing influenced his decision; the point raised by Mr. Ritchie, namely, that where the veterinarian had eliminated disease, as had been done with bovine tuberculosis in Ayrshire, the problem was not now the transmission of tuberculosis from cattle to humans but the passage of tuberculosis from humans to cattle. This demonstrated that there was quite as much onus on the medical profession to obtain a fuller understanding of disease as there was upon the veterinary profession which, in its own way, was meeting with a fair measure of success in the control of disease. It was to be hoped that both professions would co-operate to this end and meetings such as this offered every promise of co-operation. However, he felt that it must be left entirely to their own discretion in the matter of the stand they were to take on the transmission of disease from stock to humans or *vice versa*.

Dr. R. F. Montgomerie (Wellcome Research Laboratories) said that their medical colleagues had done the veterinary profession a service in producing this excellent paper. Mr. Ritchie had given him a lead in this matter. He thought his idea was to stimulate discussion, and the point he was going to raise was in that spirit. Mr. Ritchie challenged the suggestion made in the opening remarks that Table II gave an indication of the susceptibility of the animals listed to the various strains or types of tubercle bacilli, but he would draw attention to what was said regarding the incidence of tuberculosis in dogs and cats. It was stated in the paper that Lovell and White in 1940, in material offered for *post-mortem* examination, had found that 4.6 per cent. of dogs had evidence of tuberculosis, and in the next paragraph it was stated that Lovell and White in 1941 had examined 110 cats at *post-mortem* and had found four with tuberculosis, an incidence of 3.6 per cent. With the greatest of respect, his criticism arose on the next sentence: "This incidence, as that in dogs, is higher than in man." He had been brought up in a very different belief, that if a sufficient number of human beings were noted carefully there would be found evidence of tuberculosis in a large number at *post-mortem* examination. This statement by their medical friends could be misleading.

Mr. R. E. Glover (Royal Veterinary College, London) said that there were two points he would like to refer to in the paper. He was particularly interested in the section which related to viruses, and he thought in this particular field collaboration between medical and the veterinary profession had probably yielded some of the most satisfactory results which had been obtained.

He would like to ask the authors if they would care to comment on the effect of mutation in viruses. At the present moment as he saw it, they could divide the viruses into two classes. There was, first of all, the class of which rabies had been mentioned by Mr. Matthews as one which was readily transmissible from one species to another and in which the clinical disease was very acute in all those animals which it affected. There was another group, of which perhaps a good example was that of ornithosis which occurred in the pigeon and which was transmissible to man, where transmission did not take place very readily but, if the virus did become established in man and was then transmitted from man to man, it did appear to undergo some mutation whereby it became more acute in man and became a disease of the human population. There was a great deal of speculation as to why this occurred. It was possible that these viruses were made up of various components, whereby adaptation to a certain species resulted in one component becoming more dominant; the disease then became one which was prevalent in that species. He would like to know whether the authors would comment on this question of mutation in viruses.

The other point was in connexion with tuberculosis, and he would like to refer to B.C.G. vaccine. The question of the use of the vaccine to supplement the eradication scheme in cattle was considered at an early stage. The scales came down in favour of eradication alone and the results had proved quite conclusively that it was the right decision. It was highly probable that the reduction in bovine tuberculosis of cattle had had a marked effect on the incidence of non-pulmonary tuberculosis in the human population, but he thought he would be right in saying that a few years ago the medical profession had been somewhat concerned at the increase in primary pulmonary tuberculosis, particularly in young adults, although this trend was showing signs of being arrested. He would like to ask the speakers whether they thought that any tendency towards an increase in primary pulmonary tuberculosis, whatever the cause, occurred concurrently with the discovery of the antibiotics which were reasonably effective against human tuberculosis. If they had not been discovered, would the situation have become very much more serious than it was at the present moment? In view of the steady decline in human tuberculosis, what were the views of the speakers on the present campaign for the use of B.C.G. as a means of protecting certain sections or individuals of the young human population against this serious disease?

Mr. D. W. Jolly (Cooper Research Station), wished to refer briefly to the one class of disease affecting man and animals, which had not been mentioned in the paper or the discussion, disease caused by ectoparasites and endoparasites.

A recent report in the *British Medical Journal* referred to a skin disease of babies, caused by the dog or cat flea. This familiar insect has the remarkable property of remaining in its pupal stage, fixed to carpets or other furnishings, for a considerable length of time. In this case the fleas were carried by the domestic cat, and pockets of flea pupae were deposited throughout the living-room from which mother and child were infected. There had also been reports that infestations of fleas in houses in Canada were attributed to the family dog or cat.

Another common parasite of animals which could attack man, was the ascarid, *Toxocara canis*. Dr. Sprent published a paper not long ago, in which he referred to the migrations of the larval stages of *T. canis* when it entered the body of an abnormal host. This parasite, apparently disturbed by its unfamiliar surroundings, occasionally got lost and entered the brain. This occurred frequently in the mouse and rat, and, according to Dr. Sprent, there was evidence that it could also occur in children.

In conclusion, Mr. Jolly referred to a case of *Microsporum canis* in a Persian cat, which subsequently infected a number of children. Some time previously the cat had harboured *M. canis* and had been treated. Careful examinations, extending over several months, using Wood's lamp and the culture of any suspicious lesions, failed to reveal any evidence of ringworm. The cat was therefore considered cured. Within 21 days of the cat being transferred to a new home, active ringworm developed and

spread to some children. An explanation, attributed to Dr. La Touche, was that ringworm in the cat could be suppressed, and impossible to detect clinically, but that when the cat was subjected to stress, such as its removal from its accustomed habitat, the ringworm became active once more.

Mrs. D. Howell (Reading) said that Mr. Loosmore had recently investigated a case of porphyria amongst calves characterised by photo-sensitisation, pink pigmentation and loosening of the teeth, leading to progressive loss of condition. Three calves were connected in which a familial relationship existed, and on examination of the herd two further calves with the same breeding history were discovered. The diagnosis was confirmed by Professor Remmington of University College Hospital. Early publication of the details of this case was anticipated.

Miss Olga Uvarov (Cobham) said she thought they must all be very grateful to their medical colleagues for bringing this paper to the Congress; she was particularly glad to hear one of them mention that co-operation between the two professions was very necessary. She thought that they had asked and sometimes even pleaded for such co-operation in previous meetings and congresses. Having been in small-animal practices for a good many years she sometimes found it difficult to convince some doctors that the cat should not be incriminated as the source of infection in every case of ringworm in children. When running a clinic for poor people some years ago, it was quite usual to have children bringing in cats saying that they had to be put to sleep. "Doctor said so." She thought this picture had altered quite considerably now, but even so she would plead for the cat. She realised all the difficulties in diagnosis and so on, but having had one or two experiences when the cat was incriminated and infection was traced to somewhere else, she felt that the cat must be protected as well as the child.

She had one case where a blue Persian was ordered to be destroyed because two members of the family had ringworm. When the cat was examined, by every single means and by several veterinary surgeons who could not agree that the cat was the culprit, she still refused to have it destroyed without further examination of the entire family by the doctor concerned. She was told that that was not necessary, the cat should be shot. However, after further inquiry and examination it was found that the grandfather in the family had a ringworm lesion in some inaccessible and unusual place; she thought it was very charitable of her not to suggest shooting the grandfather! She fully appreciated all the difficulties of a diagnosis of this disease in the cat but, after all, the veterinary surgeon had to safeguard his patients just as much as the medical profession had to safeguard theirs.

She was interested in the reference to *C. albicans*, and would like to know if the reported cases were mainly occurring where heavy oral doses of the tetracycline group of antibiotics were being used or, as had been reported, not only used but unfortunately sometimes misused. She would like to know if there was an increased incidence of moniliasis as a result of antibiotic therapy because on the veterinary side this was not encountered and *C. albicans* had not been reported in the conditions quoted. Nowadays, with the extended use of broad-spectrum antibiotics possible side effects from these should be considered and carefully reported.

The Reply

The Chairman (Mr. E. R. Corrigall) said that the discussion seemed to have exhausted itself and it remained for him to ask the authors to reply. In fairness to Dr. Prior and Dr. Arblaster he would like to point out that it had been difficult for them to get every point made by the speakers.

Dr. Prior, in reply, said that this had been a most stimulating and interesting discussion. A very considerable number of points had been brought out and he did not think he could deal with all of them.

First, in reply to Dr. Barron, they found the giving of a title to this paper was a very difficult matter and they would be glad to change it if he could suggest a better one. On the subject of *Salmonella*, which several speakers had mentioned, there were no less than 313 named types, a certain number were encountered in human work and there were a certain number of chronic carriers. He thought he had mentioned one in the paper which might be associated with an animal type, but of course most of them, or quite a reasonable proportion of them were known to affect animals as well as man.

It was necessary in dealing with their experience in South Warwickshire to eliminate quite a few subjects; they had tried to keep those of the greatest importance and those which were particularly interesting. He made no apology for mentioning leprosy if it produced information, however acquired, about the occurrence of rat leprosy; it would, so far as he was concerned, have served its purpose. There had been a couple of cases of human rabies in this country within the past year, one of which occurred in the Midlands. The pathologist who dealt with the case told him he had rung up the local Medical Officer of Health at midday on Saturday and at midday on Monday the M.O.H. was still "batting his head against the wall."

The problem of smog or fog fever was rather outside their immediate brief, but he understood that the Medical Research Council had a research team at work on it. In reply to Mr. Ritchie, they had managed to isolate brucella from human cases only once in the past three years and that was a case of *Br. abortus*. They looked for it in cases of unexplained fever very frequently but until the recent investigation with veterinary surgeons they had never encountered it frequently in the human being.

In reply to Mr. Barton Mann, all he could say was that he must compliment him on the extreme excellence of his laboratory discipline. He would leave the figures for evidence of tuberculosis to be dealt with by his colleague. In reply to Dr. Montgomerie, the last time they went through their *post-mortem* figures, the incidence of tubercle was just over 1 per cent. He felt quite incompetent to make any cogent remark in reply to Mr. Glover and the matter of mutation of viruses. It was such a deep and difficult subject that he felt it could only be dealt with by his old chief, Professor Burnett.

He was very interested in the remarks of a few speakers concerning ringworm. He agreed that it was always very necessary to search all possible contacts and not just to impeach one animal as being the contact without very good reason. Mr. Jolly, of course, had illustrated the excellent purpose to which human inoculation could be put in proving a disease.

Most cases of candidiasis which they encountered, fortunately there were only very few, followed massive administration of antibiotic therapy. He agreed that it was very difficult to word this sort of thing properly in reporting, but the association seemed to be very strong, certainly as strong, if not stronger, than the association of lung cancer and cigarette smoking.

Finally, they had been subjected to a certain amount of quite good-natured criticism which they took in the spirit in which it was given, but perhaps he might just add that he had hoped more veterinary people would have been interested in brucellosis in humans.

Dr. Arblaster, also in reply, said that it had been a great honour to have read the paper. Mr. Matthews gave them a most valuable introduction and he wished they could have written something half as well. With regard to histoplasmosis, he would like to say that animal-to-man infection was only a possibility but there had been these six cases. The most important source of the organism was the soil which lay around the Mississippi Valley. Dr. Barron was distressed that so much of the paper was concerned with bovine tuberculosis; 200 people last year died from it and that was their justification for mentioning it.

One saw psittacosis in the Midlands, particularly in Coventry and there was one store in Birmingham which had supplied pigeons which carried the virus. It was a pity that human brucellosis was not notifiable, he was not aware of the fact that in 1927 a number of veterinary surgeons

had brucellin tests. The only literature he could find relating to this was from the United States where in 1944, 40 per cent. of the attenders at the Veterinary Congress were positive brucellin reactors.

He thought Mr. Ritchie answered Mr. Downham's point. He said that 2.3 per cent. of milk samples were shown to contain bacilli and that had risen in 1955 to 3.8, a difference of just over 1 per cent., and he doubted whether it was significant. He thought the probable reason for it was the officer's knowledge of the various farms. He would like to thank Mr. Ritchie for information which was quoted in the paper. Table II which showed the strain of microbacteria in various animals was compiled mainly from the work of Mr. White and other published material. It was possible that Mr. Ritchie had published material on types and strains of which he was not aware. They were aware that the human bacillus did not cause progressive disease in cattle.

Dr. Prior had replied to Dr. Montgomerie, but he would mention that on X-raying random samples of the population they found that approximately 3 per 1,000 of human beings had tuberculosis. There had been published work on *post-mortems* of random cases; the figure of disease of the lungs was 1 per cent., which contrasted favourably with the figure of between 3 and 4 per cent. in cats and dogs.

With regard to B.C.G., there was evidence that as a result of giving this to children the form of disease was becoming more acute than had been seen before. He did not think the work was particularly well controlled, but the suggestion had now been made that those cases which did occur were more acute than were seen in pre-B.C.G. days. The main point was that the incidence of disease was very much reduced. Mr. Glover asked whether the influence which the antibiotics might have could be the reason for the reduced incidence of new cases. He was sure that antibiotics had reduced the injector pool of human tuberculosis. The bovine strain in human beings as a cause of pulmonary tuberculosis was very rare in the British Isles. He did not think the figure of 16 per cent. was applicable. He did not think cattle would be greatly at risk to bovine bacilli from human pulmonary cases.

The Chairman thanked the authors, Dr. Prior and Dr. Arblaster, very sincerely for their paper. He thought that the title was a very happy one, it was intended to bring the two professions together and to that extent it had succeeded. The best tribute to the authors had been the discussion on the paper and the attendance at the session, one of the best throughout the Congress.

Examination of the Eye with Special Reference to the Horse and Dog

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"Scientific observations can only be fostered by methodical investigations."—Parsons.

NOTHING could be more apt when examining the eyes of animals where subjective symptoms are absent and the complete co-operation of the patient not assured.

Equipment

For examination of the eye the following is required:—

1. A simple electric ophthalmoscope containing a battery in its handle. More complex instruments with a mains electricity supply and equipped for slit lamp microscopy and other procedures can be obtained but are not essential.
2. A concave ophthalmic mirror.
3. A condensing lens of approximately 14 diopters —focal length of just less than 3 inches.
4. A corneal magnifying lens of 8 to 10 diameters magnification (corneal loupe).
5. An electric lamp—an angle-poise lamp is satisfactory.
6. Drugs. A 2 per cent. fluorescein solution; a 2 per cent homatropine solution or lamellae; a 4 per cent. cocaine solution or tablets.

Methods of Examination

1. *External Examination*

This can be regarded as a general inspection with the unaided eye for obvious abnormalities. Conditions of the lids, injuries, ptosis, blepharitis, entropion, ectropion, tumours are noted. A corrugation or wrinkling of the upper eyelid in the horse infers a previous attack of periodic ophthalmia with subsequent bulbar atrophy. Attention is given to the movement, size, and shape of the eyeballs—exophthalmos, microphthalmia, hydrophthalmos, staphyloma.

The horse is best examined in a diffuse light and a convenient place is at the entrance to a stable door with the head facing outwards. The dog can be placed on a table conveniently near to a window and small, nervous patients can be held overlooking the owner's shoulder facing a window.

If desirable at this stage, a preliminary or cursory examination can be made of the anterior segment of the eye—cornea, anterior chamber, iris, lens. This applies particularly to the horse when opacities may be detected but not accurately located by protecting the eye from extraneous light reflections with a black disc. This, however, should not be regarded as a diagnostic procedure.

2. *Focal or Oblique Illumination*

Whenever possible this should be conducted in the dark room, but this requirement in the dog and horse is not essential provided the examination takes place in a diffuse light when the pupils in both species remain moderately dilated. The method consists simply of the concentration of a source of light—angle poise lamp or electric torch—on to the anterior structures of the eye by means of a strong convex lens (14 D.). The rays of light can be brought to a focus on any part of the cornea and by bringing the lens nearer to the eye, light can be concentrated on the iris and also on the lens. The brightly illuminated spot is now viewed through a strong convex magnifying lens or corneal loupe. With both hands engaged and the tendency of the patient to move its head, the procedure may become tedious. For this reason a binocular loupe, often with its own source of light attached, with retaining head band enables one hand to be free to assist in controlling the animal. A binocular loupe has the added advantage of giving stereoscopic vision. Magnification, however, is less.

In my view, a magnifying glass or, infinitely better still, a binocular loupe is indispensable for a critical examination of the anterior segment of the eye. In unco-operative subjects it is not always possible to employ a condensing lens, in which case light can be concentrated on the eye directly from a pencil-type torch.

Ophthalmoscopic Examination

The assistance of the ophthalmoscope is necessary for the examination of the posterior segment of the eye—vitreous and fundus. The instrument in its simplest form consists of a concave reflecting mirror with a central aperture. Rays of light from a natural or artificial source of light are reflected into the patient's eye and return to that of the observer in the opening in the mirror. With the latter held close to the observer's eye extraneous rays of light are excluded. The disadvantage of the ophthalmic mirror is that a separate source of light is required. Even so, this century-old discovery, the father of all ophthalmoscopes irrespective of their complexity, is still popular amongst veterinarians and can be used effectively for the diagnosis of opacities in the refractive media of the horse in diffuse daylight. The modern type of ophthalmoscope provides its own source of light and is more adaptable for use in the dark-room. In addition it carries a series of convex and concave lenses which by rotating a milled disc can be brought into position behind the aperture. Held close to the observer's eye and approximately 10 inches from that of the patient, a general view

of the refractive media is obtained (distant direct method). For a detailed inspection of the fundus the ophthalmoscope approaches the eye as closely as possible (direct method) giving a magnification of 15 times. With a +15 D. to +20 D. lens in the aperture, the cornea, anterior chamber, and lens can be examined under magnification similar to that obtained in focal illumination.

Examination of the Individual Ocular Structures and Adnexa

Eyelids and Eyelashes

Intermittent blepharospasm suggests irritation of the cornea by a foreign body or misdirected eyelashes. An entropion may be obvious but the small cilia in distichiasis may not be so readily detected without the employment of a magnifying glass or loupe. Depilation of the skin or even staining of the hair at the inner canthus may warrant investigation of the lacrimal apparatus.

Conjunctiva and Conjunctival Sacs—Foreign Bodies

Frequently one sees a dog with a hair across its cornea to which it is completely oblivious. Inspection of the intruder with a loupe will reveal that it is not in intimate contact, with the cornea because by capillary attraction it is surrounded by lacrimal secretion or mucus and it is mobile.

Foreign bodies irrespective of their nature only cause trouble if they penetrate the corneal epithelium. Occasionally a particle of grit or a stubbly piece of hair invades or anchors itself to the palpebral conjunctiva and irritates the cornea when the lids are closed. Fortunately the horse is relatively immune to such lesions, but in the dog, where intermittent blepharospasm and lacrimation can be ascribed to no definite cause, the eyelids, including the third eyelid, should be everted and examined with a loupe. The instillation of fluorescein solution will stain ulcerated or eroded areas of conjunctival mucosa a bright yellow colour in the centre of which foreign bodies are occasionally found. Painful procedures should be facilitated by the topical application of a 4 per cent. cocaine solution. Conjunctivitis may be indicative of systemic disease or an ocular lesion *per se*. A localised hyperaemia of the anterior ciliary vessels at the limbus is often the first indication that all is not well with the adjacent cornea and a careful examination of the latter may reveal a simple lesion, which if neglected, especially in such dogs as pekes and pugs, could develop into an ulcer. Congestion and increased prominence of the conjunctival and ciliary veins point to increased intraocular tension or glaucoma and in the dog this almost invariably means an incipient or definitely clinical luxated lens.

Intraocular Tension (Tonometry)

Tension of the eyeball should be practised as a routine if for no other reason that one gets familiar with what can be regarded as normal. It is estimated by palpation of the eyeball through the closed upper lid with either the index or second finger. Increased tension—hypertony, is observed in early glaucoma in the dog and the initial phase of iridocyclitis in the horse. Hypotony is associated with hydrophthalmos in the dog and ocular atrophy in the horse.

The Lacrimal Apparatus

Congenital absence or obstruction of the lacrimal passages results in epiphora and staining of the hair at the nasal canthus. Absence of the puncta lacrimalia does occur in the dog but more frequently obstruction —congenital or acquired—is located in the naso-lacrimal duct. The patency or otherwise of the drainage channels can be determined by the introduction of a drop of fluorescein into the eye to be examined. If patent, a green fluorescent colour appears at the nasal opening within a few minutes. In the normal puppy it will appear within 20 seconds. Irrigation with a lacrimal cannula should produce similar results. Lacrimal cannulae or probes must be passed in the dog via the punctum in the upper lid when they are conducted automatically by a groove in the lacrimal bone into the opening of the osseous nasal canal. If the lower punctum is used, the cannula or probe will have to turn almost at right angles to enter the canal. A strand of monofilament nylon of appropriate thickness serves as a useful lacrimal probe. It may not be persuaded to appear at the nostril but its advent into the nose is usually accompanied by attempts at sneezing. In the horse, patency can be investigated by irrigation via the nasal opening of the naso-lacrimal duct.

The Cornea

The cornea, in animals, in relation to the size of the globe, is large and is partly covered by the lids when the eye is open to its normal extent. It should be perfect in outline and its surface should be glistening and transparent. Keratoconus may be due to a previous keratitis or a staphyloma. A normal cornea provides a perfect reflecting surface and any defect in its surface can be detected by any distortion of the mirror reflection. If the dog is placed near to a window, reflection of the window on the cornea will be disturbed if its surface is irregular. The cornea of the horse can be similarly examined by observing the image of a candle flame held before it in a darkened box. For a detailed examination of the cornea it is essential to have a good source of light, a condensing lens, a corneal loupe, and a staining agent. One cannot overestimate the value of the latter. When a minute drop of fluorescein is put in the eye, any breach of the corneal surface epithelium is stained a brilliant green. Small lesions and areas of erosion possibly caused by foreign bodies or misdirected eyelashes are readily missed by the naked eye if not revealed by this technique. Foreign bodies which are buried in the cornea and covered by epithelium must be examined with a loupe to discover direction and depth of penetration. Vascularisation of the cornea should also be examined under magnification. Superficial vessels are bright red in colour and are continuous with the conjunctival vessels. Their branches are arborescent. Once the lesion responsible for their presence has healed they disappear. Deep vessels are darker in colour, less distinct, and can be traced only to the limbus. Their

branches lying between the lamellae are not allowed the free movement of superficial vessels and are compelled to travel more or less in straight lines. Deep vascularisation indicates a chronic keratitis. Frequent sequelae are faceting of the cornea and melanotic pigmentation.

Corneal dermoids should be examined very carefully prior to their removal to detect minute hairs which are invisible to the naked eye, otherwise in a few weeks' time a second operation has to be performed. Localised corneal opacities may be congenital or due to trauma. It is more important, perhaps, that they should be discovered in the horse when examining it for soundness than in the dog. It is very questionable whether in either species a small opacity of cornea or lens interferes with vision. It is not difficult with a loupe to discover the relative position of these opacities irrespective of their density. A sub-central localised opacity of the deeper layers of the cornea in the dog points to pressure from within by a dislocated lens pressing on its posterior surface.

Precipitates on the posterior surface of the cornea (*keratitis punctata*) are only rarely seen in the dog but are by no means an unusual sequel to recurrent iridocyclitis in the horse.

A diffuse haziness of the cornea generally suggests increased intraocular tension and in the dog may be traumatic in origin. In the Wire-Haired Fox Terrier and Sealyham it should arouse suspicions of lens displacement. Digital pressure on the eyeball invariably increases the opacity especially towards the centre of the cornea where pressure is highest and lymph circulation poorest.

Sensitivity of the cornea can be assessed by touching it with a wisp of wool or even the finger-nail. Lack of response may mean injury to the ophthalmic branch of the fifth nerve or to local changes in the cornea as in gross damage by caustic agents such as quicklime.

The Anterior Chamber

This is next examined for transparency and depth. Turbidity of the aqueous is rarely seen in the dog but is rarely absent in iridocyclitis in the horse which accounts for the frequency with which posterior corneal precipitates are seen in so-called periodic ophthalmia. In the dog, leucocytic exudates aggregate themselves to fall into the bottom of the anterior chamber—*hypopyon*. This signifies a deep corneal ulcer and is in the nature of a warning that if a paracentesis operation is not done, perforation will occur. If, in inflammation of the uveal tract of the horse hypopyon occurs as against a turbid aqueous, the prognosis, in my experience, is more favourable. Hyphaema or blood in the anterior chamber generally follows local injury. If excessive it can provide the medium for attachment of iris to lens and/or glaucoma. In the majority of cases in the dog it is unilateral and not serious. Its presence is more alarming to owner than patient but several weeks or even months elapse before absorption is complete. Hyphaema in the horse may arise from blows about the eye but may be due to self-inflicted injury because of loss of visual acuity. Variations in depth of the anterior chamber in the dog are usually associated with alteration in the position of the lens. If the lens is tilted, one part of the anterior chamber is deeper and the other part shallower. If an appreciable degree of glaucoma is present then the anterior chamber is distinctly shallower. One must not overlook the fact that the anterior chamber in the dog may be occupied by a dislocated lens.

The Iris and Pupils

These are best inspected under ordinary conditions of light for a true evaluation of the direct and consensual light reflexes. It takes strong artificial lighting even to approximate natural light. On the other hand, if dilatation of the pupil is an advantage to examination, then focal illumination is preferable.

Attention is first given to the colour of the iris. The irides may differ in colour—*heterochromia iridis* and there may be partial or complete albinism of one or both. It is well to remember that when this phenomenon prevails the tapeta also differ in colour. A dull, lustreless so-called "muddy" iris with a constricted pupil is typical of iritis. Adhesions either to the lens (*posterior synechia*) or to the cornea (*anterior synechia*) occur in both the horse and dog. In the horse it is usually posterior subsequent to an attack of iridocyclitis and in the dog anterior following penetrating wounds of the cornea or a perforating ulcer (anterior staphyloma). Posterior synechia is infrequently encountered in the dog but when it does occur it is usually annular and gives rise to glaucoma. Synechiae produce irregularities of the pupillary margin but to demonstrate these the use of a mydriatic may be required. Homatropine for this purpose is superior to atropine. It acts more quickly and the effects pass off more quickly.

Any inflammatory reaction of the uveal tract can be demonstrated by injecting fluorescein solution intravenously. A positive reaction is a fluorescence of the aqueous, or a fluorescent halo is seen to cling to the iris at its pupillary margin. In the average terrier-type dog 2 ml. is sufficient and in the horse 10 ml.

In the dog, with movement of the eye, a quivering or tremulousness of the iris—*iridodonesis*—signifies a pathological relaxation of the suspensory ligament of the lens and the latter is tending to fall away from the iris which it normally supports. This syndrome is pathognomonic of impending luxation of the lens. Occasionally, in both horse and dog, strands of uveal tissue are seen to pass from the pupillary margin or adjacent parts of the iris to the anterior surface of the lens or from one side of the pupil to the other. At other times strands pass from the iris to meet in the centre of the pupil, somewhat resembling a spider in its web. These are different manifestations of the same congenital defect and represent the foetal remnants of the anterior vascular sheath of the lens—*Persistent pupillary membrane*. In its most degraded form a series of pigmented dots are seen on the anterior lens capsule. Another congenital defect seen in the dog is where there are several openings in the iris exclusive of the pupil—*polycoria*.

Pupil Reflexes

Constriction of the pupil takes place when exposed to light (*direct reaction*) and at the same time constriction of the opposite pupil occurs (*consensual reaction*). Constriction also takes place with accommodation and convergence. Dilatation of the pupil occurs when the eye is shaded and when the eye changes from near to distant vision. It has often been said that the dog is peculiar in that it behaves conversely from other species and dilates its pupil for near vision and constricts it for distance. This is not altogether true and depends on the intensity of light present. The range of accommodation in the dog is not wide and its reaction to light is by no means as brisk as in man. In a fairly bright light for near-point vision one sees convergence and constriction of the pupil. In veterinary practice, chief reliance is placed on the *direct light reflex* although on the odd occasion when monocular blindness occurs from no apparent reason, the *consensual light reflex* will assist in determining whether the lesion is along the afferent or efferent pathway. The dog's pupil reflexes can be examined in a diffuse light or the dark-room. A bright light is brought in front of both eyes and any disparity in the size of the pupil is noted. Then each eye is covered in turn whilst the light is brought to bear on the one which is open. One then observes the rate and degree of contraction—*miosis*. A sluggish contraction with a ready tendency to dilatation—*mydriasis*—when the light source is removed may be connected with incipient glaucoma (lens subluxation) or the early stages of retinal degeneration. In both these diseases the two eyes may not be involved to the same degree in which case there will be an obvious difference in the *direct* and *consensual* light reactions. Permanent mydriasis suggests an absolute glaucoma (*hydrophthalmos*), complete retinal atrophy, retinal detachment, a lesion of central origin, or one affecting the optic or third nerves. Provided the remainder of the visual apparatus is normal a cataract irrespective of extent and density does not influence the light reflex. Mydriasis in the horse is generally a symptom of blindness due to disease of the retina or optic nerve and as in the dog one eye may be affected worse than the other.

The Lens

No great difficulty is attached to the examination of the lens in the horse or dog and it is seldom that dilatation of the pupil with mydriatics is required. The defects one looks for are opacities—cataract—in the horse and dog and lens displacement in the dog. The ophthalmic mirror is a useful instrument for the diagnosis of opacities of the media in the horse and the source of light is readily supplied by a window, electric light, or torch, but to find the exact location of these opacities the modern ophthalmoscope with its own source of light is more convenient and preferable. The dark-room is better than daylight. Focal illumination is not eminently satisfactory for the diagnosis of cataract but under it opacities are greyish-white in colour. When seen through the ophthalmoscope they appear dark grey to black against the background of the tapetal reflex. The ophthalmoscope with no lens in the aperture is held close to the observer's eye and then brought slowly to within reading distance, 9 to 10 inches, of the eye to be examined (*distant direct ophthalmoscopy*). By slight adjustment of distance the cornea and then the lens can be brought into focus. At the point where an opacity is most clearly defined it is possible, with a little patience, to determine its position by *parallax*. A central opacity in the front part of the lens will appear to remain in the centre of the pupillary tapetal reflex irrespective of movement of the eye. An opacity on the posterior part of the lens will move in the opposite direction to that of the eye. Opacities in the vitreous will also appear to move in the opposite direction but they are not fixed and move after the eye has come to rest. If magnification of an opacity is required, a +10, +15, or +20 D. lens is rotated into the aperture of the ophthalmoscope and the same procedure of approaching the animal's eye is followed. It will now be necessary to get much closer to the eye before the cornea comes clearly into focus. Getting still closer the iris comes into focus and of course the anterior surface of the lens. Opacities here and in the deeper part of the lens will now become clearly visible as dark shadows. A +10 or +21 D. lens is more appropriate to the horse because of the difficulty of getting close to the eye. It may not be out of place here to warn the uninitiated not to confuse the *radii lentis* with cataract in the young animal although opacification of the centre of the lens in the young dog frequently commences along these Y-suture lines (*embryonic cataract*).

It is my experience that a subluxated or luxated lens in the dog is not readily discovered. Suspicions are probably aroused by increased intraocular pressure and a sluggish pupillary light reflex, and especially if the dog is a Wire-Haired Fox Terrier or a Sealyham. As already mentioned *iridodonesis* is diagnostic of an incipient subluxation and it is at this stage that the lens should be extracted if the best results are to be achieved. A diffuse corneal opacity presents some difficulty to diagnosis but with focal illumination at the limbus, the iris, pupil, and anterior chamber can be seen. The most difficult luxation to detect is when the lens has recently passed completely into the anterior chamber and before it has had time to become opaque. The part of the lens to be looked for and most easily recognised is its equatorial edge which under focal illumination will appear as a greyish-white line. A subluxated or tilted lens, partly in the posterior and anterior chambers should present no obstacle to diagnosis. An aphakic crescent—luminous under focal illumination—is seen between the pupillary margin and the edge of the lens and the part of the iris which now has the lens in front of it is brighter in appearance than its remainder. Torn or stretched zonular fibres may be seen by direct ophthalmoscopy with a +12 or +20 D. lens in the aperture. If the lens remains virtually in its normal position because of adhesions between its posterior capsule and the hyaloid membrane, the aphakic zone between the edge of the lens and the pupil is completely ring-like. A lens lying in the vitreous is usually opaque. The whole of the pupillary area is aphakic and the eye is

hypermetropic. In some cases a dislocated lens is seen to move with movement of the eyeball.

The Vitreous

Haemorrhages into the vitreous are uncommon in animals. Following severe trauma about the head—the last case seen was in a Corgi which fell on its nose from a motor van—haemorrhage in the dogs' vitreous is usually massive. Absorption rarely takes place, retinal degeneration and blindness are the sequelae. Recognition is by focal illumination or with a +12 D. lens in the aperture of the ophthalmoscope. It is impossible to view the fundus.

The Fundus

For a detailed examination of the fundus of either the horse or dog, an electric ophthalmoscope is required and if the whole field is to be explored without the use of mydriatics it must be conducted in the dark. To get the best from this instrument a little practice in its use is helpful and for this purpose an eye as an objective is not essential. The observer can concentrate on small objects, the skin at the back of the hand, or small print in a book. At ordinary reading distance he will find that looking through the aperture of the ophthalmoscope held close to his eye with no lens in position the object or print will be clear. This is assuming that the observer is emmetropic or that errors of refraction have been corrected with spectacles. At this distance the emmetrope will find the image slightly blurred with a convex lens of 2 diopters in the aperture but on the other hand if minus lenses up to 3 diopters are rotated into the aperture he will probably find the image still clear. This is due to involuntary accommodation which comes naturally for near vision. If more than a −3 D. lens is used the image becomes out of focus and remains blurred irrespective of the distance from the object. On the other hand, if convex lenses are substituted by approaching the object, it again comes into focus and with some magnification. The stronger the lens used the nearer one must get to the object and the greater the magnification.

This is the principle on which the simple ophthalmoscope is used. As mentioned earlier much more complex instruments can be purchased, which, with the aid of the instruction book sold with them, enable the observer to make more detailed calculations more academic than practical in animals.

The next step is to examine an eye and become familiar with the normal fundus in all species. With the instrument held close to his eye and no lens in the aperture, the observer gets as close to the objective eye as possible for if both are emmetropic a clear view of the fundus is seen. If there is any tendency to accommodate, the observer may not get a clear view until this has been neutralised with a minus lens, possibly up to −3 D. It is not difficult to get a general view of the tapetal fundus in the dog or horse but a protracted examination of the optic disc is not easy because of movement of the eyeball. One should not, so to speak, chase the disc but wait for the eye to return to its former position. It is more difficult to see the optic disc in the horse than in the dog. The optic disc in the former species is in the lower outer quadrant of the fundus and well ventral to the horizontal meridian so that light has to be directed somewhat downwards over the lower border of the pupil and the upper eyelashes can easily get in the way. The tapetum in the dog is more iridescent than in the horse and exhibits a much greater variation of colour. The optic disc is irregularly round, oval, or somewhat triangular in outline and pale pink in colour. The main retinal vessels are in three groups. The arteries arise singularly from the disc but the veins join up to form a complete or incomplete venous circle. The optic papilla in the horse is oval and faintly pink. The vessels are small and numerous and radiate from its periphery.

The horse suffers rarely from disturbance of its retina serious enough to cause poor vision unless they are secondary to, or consistent with, other inflammatory changes in the eye. There are occasions, however, when there is a history of partial or complete blindness unilateral or bilateral when there are no obvious lesions in the anterior segment. The pupil shows a tendency to mydriasis or is permanently dilated and the light reflex is poor or absent. Examination of the fundus is relatively easy in these circumstances and it is usual to find a white or greyish-white disc which is completely devoid of vessels, suggesting a retinal degeneration. Retinal degeneration in the dog is again associated with the gradual loss of the pupillary light reflex, changes in the tapetal fundus and finally with a completely avascular fundus and disc.

Retinal detachment, provided the media are clear, is most picturesque in the dog and easily recognisable in both horse and dog. In both species it is accompanied by varying degrees of mydriasis—usually absolute in the dog. The detached portion of retina in the horse is generally localised and greyish-white in colour whereas in the dog it involves the greater part of the fundus in both eyes and is a very pale diffuse pink or flesh colour. The retina is raised in a series of overlapping blisters not unlike the ripe follicles of the bitch's ovary. It is impossible to trace the continuity of the retinal vessels. The eye is grossly hypermetropic and to get a clear image of the detached portion a +10 to +12 D. lens has to be brought into the sight hole of the ophthalmoscope.

Functional Examination

Acuity of vision in animals is not readily assessed and when questions are asked on the degree of blindness present it is not always easy to provide the answer, for the simple reason that if the blindness comes on gradually animals so readily adapt themselves to their surroundings, especially the dog. Animals which are completely blind depend more upon the sense of hearing. The horse pricks its ears and stands in the direction from which the noise has come. The dog also relies on its sense of smell. Blundering into obstacles either accidentally or when deliberately put in the animal's path is inevitable.

In monocular blindness the sound eye must be covered.

Palpebral Reflex

After drawing the animal's attention to one's presence by tapping it lightly on the head, threatening movements are made towards the eye, at the same time avoiding the creation of a draught and contact with the eye-lashes. The absence of a blink reflex should arouse suspicion.

Pupillary Reflex

Permanent dilatation of the pupil in strong light can be regarded as almost pathognomonic of monocular or binocular blindness.

In partial blindness some degree of reliance has to be placed on the history contributed by the owner but it is only by systematic examination of the eye itself that a true assessment of vision can be made.

Summary

Precise and methodical examination is essential in ophthalmology. Naked-eye examination has its limitations. Aids such as the use of a staining agent, good illumination, magnification, and the use of the ophthalmoscope play an important rôle in accurate diagnosis. Following a detailed scrutiny of its adnexa the ocular structures are examined serially commencing with the cornea and ending with the fundus. For the structures comprising the anterior segment, focal illumination plus magnification with a binocular loupe is a distinct advantage over naked-eye examination. For the posterior segment, an electric ophthalmoscope is essential. An attempt has been made to deal with the diagnostic features of most of the principal lesions encountered in the horse and dog.

THE SPEAKER'S INTRODUCTION

The Chairman, Major F. Chambers, said that the author did not need any introduction and there was no need to extol him. They would be grateful if he would make a few introductory remarks before the paper was discussed.

Professor C. Formston in introducing his paper said: "First of all, I do thank the British Veterinary Association for inviting me to present this paper. I had some misgivings after I agreed to write it for the simple reason that the subject appeared to me to be rather limited, and one had to embellish a little by going round the scope of the exact title of the paper. In the main I have tried to blend the old with something that might be not exactly new but perhaps not so commonplace as methods used by veterinary surgeons generally some decade or so ago.

"There is no doubt that in the examination of eyes of animals it is essential that the animal be controlled without interference. It is hopeless to manhandle the animal's eyes because of lack of co-operation on the part of the patient. If one can resort to the assistance of local anaesthesia it is all to the good.

"I was asked to write this paper with special reference to the horse and the dog. In connexion with the horse there is no doubt that preliminary examination with the old familiar black disc is a prerequisite to a more detailed study. It is no use ridiculing the older methods and saying one should immediately resort to the use of an ophthalmoscope. In the first instance a naked eye examination is essential, followed by a systematic examination of all the ocular structures from before backwards, using such aids as are available. The principles embodied in most of the instruments useful to diagnosis are light and magnification and if one can see things more readily and easily with an instrument than with the naked eye it should be employed. There is a tendency for many people to believe that an ophthalmoscope is a complicated mysterious instrument requiring special skill in its use. This is not so. With a little practice in its use one can derive a great deal of pleasure by exploration of the eye and seeing things invisible to the unaided eye.

"I would now like to make reference to palpebral nerve block. This nerve—a branch of the facial—supplies motor power to the orbicularis oculi muscle which is responsible for closure of the lids. By blocking this nerve we prevent the animal from closing the lids and thus examination of the eye is made easier. We have used this nerve block in dogs and cattle for many years to assist in examination of the eye and to enable photographs of ocular conditions to be taken. In the horse it is difficult to block the nerve without including the branch going to the ear. On occasion the main facial trunk has been affected with the result that a facial paralysis (transient) has developed. In cattle it is extremely useful in extracting foreign bodies from the cornea. The nerve is blocked as it passes over the zygomatic process of the temporal bone and I have with me some slides showing the technique and results of this nerve block in cattle as described by Maksimovic (1950)."

The slides were then shown.

The Opener

Mr. S. F. J. Hodgman (Newmarket) said: "May I be one of the first to thank Professor Formston for his excellent paper.

"The subject, which has in the past been somewhat neglected by the veterinary profession as a whole can, and should, be developed to a much greater advantage for diagnostic purposes. Only an author who knows his subject thoroughly could have put so much into the paper that has been circulated, and we owe our thanks to Professor Formston for the trouble he has taken in condensing and clarifying his material for our benefit.

"I am the only one who has legitimate cause for complaint, since by denying me gaps to fill in and grounds for disagreement, he has made my task of opener more difficult. In the circumstances, I intend to touch only upon some of the points in the paper that particularly interest me, to emphasise others which I consider of the greatest importance, and to add a few comments suggested by my personal experiences.

"It is not so very long ago that it was unusual for the modern ophthalmoscope to be seen in the average veterinary surgeon's instrument case, but over the last 10 years or so an increasing interest has been taken in veterinary ophthalmology, greater attention being focused on the examination of the eye as an aid to diagnosis.

"For obvious reasons more attention was paid in the past to the horse's eye than to the dog's, but lately more and more thought is being given in general to the subject especially since small-animal work is of increasing importance in so many practices. Economic and other factors are apt to limit us and preclude a veterinary treatment comparable to that which is accorded to human beings, a handicap under which the veterinary profession has always worked, but even so our progress is undeniable and we gladly welcome more information on this vital subject.

"My remarks apply in particular to the examination of the posterior part of the eye, the fundus. Knowing the structure and the functions of the eye, the examiner should experience little difficulty in his initial observations, but for those taking a greater interest in the subject there are now a number of excellent books on the market. The beginner, however, would be well advised to study normal eyes as often as possible and so get a clear picture through the ophthalmoscope, since no amount of instruction or reading alone will take the place of looking at the normal fundus.

"At this point I should like to emphasise the absolute necessity of getting to know one's own ophthalmoscope. Admittedly one can get along with anyone else's, but it is, in my opinion, a great advantage to keep to the same instrument, and so familiarise oneself with its idiosyncrasies. As Professor Formston has told us, this

can be done to great advantage by the practice of reading small print through the ophthalmoscope, thus synchronising hand, eye and instrument. To my mind, real efficiency with the ophthalmoscope can only be achieved by such a combination working harmoniously. Another very good way to familiarise eye and instrument is by looking at human eyes. The average human being is, under such circumstances, more long suffering than the general run of our patients, and we most of us find the victimisation of our nearest and dearest quite a simple matter in such a cause.

"I find it of great service to study colour plates in text-books on ophthalmology with an ophthalmoscope; only when one is reasonably skilled should the examination of animals' eyes be undertaken. Another point is this: always see that your battery is a good one because if the light is not powerful enough and the instrument is not attached to the mains, a poor light can make a very great difference to its efficiency, since only very gross abnormalities will be observed. Professor Formston has gone very completely into the methods of examining the eye and of using the ophthalmoscope, but there are one or two points in this connexion upon which I should like to enlarge.

"In examining the dog's eye it is often difficult to maintain a contact view of the fundus because the patient tries to shift its vision. This can often be overcome by getting an assistant, while holding the animal, to press slightly with a finger against the lateral side of the eyeball and so minimise movement. Care must be taken that there is no unnecessary pressure.

"Occasionally it is necessary to dilate the pupils with atropine for a more thorough examination, especially when there is an abnormally small pupil which makes examination of the retina difficult. The undesirable effects of this can be overcome by instilling one or two drops of a 1 per cent. eserine solution.

"I should also like to emphasise the fact that both horses and dogs are much less resentful of having their eyes examined in semi-darkness than in the full light. They appear less apprehensive, or perhaps they are only subdued by the want of light, but whatever the cause they are certainly more tractable in semi-darkness. Another point to be noted is that they object less to a small beam of light than to a broad glare.

"In so far as the examiner is concerned, I think it is advisable that he or she should check up on his or her individual ability to distinguish colours correctly. This is of the utmost importance though it may sound absurd to many of you. I can assure you that quite a number of people are totally, or in part, colour blind and only discover the fact by chance sometimes quite late in life.

"Apart from knowing one's own ophthalmoscope one must be thoroughly conversant with the normal eye. I know that I have said this before, but I must again insist on its vital importance. This knowledge can only be acquired by continual practice in observing normal eyes and studying the minute differences in them. Believe me a thorough understanding of the normal is the only sound foundation upon which a diagnosis of the abnormal can be built; particularly is this so with regard to the many variations in the normal which must be recognised. Only in this way can you avoid the great risk of mistaking a variation of the normal for a pathological condition.

"In carrying out an examination of the eye it is a good plan to adopt a regular routine that one arranges for oneself and never varies. After a time each act of examination falls naturally into its appointed place so that nothing is forgotten. This method is of particular value in the case of the fundus, and it may be as well to start with the optic disc. This is normally round or very slightly oval, and has sharply defined edges, the whole being pinkish in colour and situated medial to the centre of the eye. Normally it lies flat against the retina but there may be a slight depression in the centre where the blood vessels rise. This depression is called the 'physiological cup' and I mention it particularly as it must not be confused with the deep cupping seen in cases of glaucoma.

"The blood vessels vary in their positioning from eye to eye, but can be easily distinguished as arteries or veins, the latter being somewhat darker in colour and larger in comparison with the arteries. There appear to be more retinal vessels in the horse's eye than in the dog's, but I do not know why this should be so.

"Over the upper portion of the retina we see the brilliant blue-green or yellowish-red tapetum lucidum. This colour differs from breed to breed and in some cases from dog to dog, and it is held by many people that the variation is associated with the animal's body colour; I'm not so sure about this myself.

"The tapetum nigrum is situated in the lower portion of the fundus and is usually dark brown in colour. Over the non-tapetal portion of the retina the fundus is a uniform pink or red colour.

"I know that Professor Formston has gone into the anatomical structure of the eye in his paper, but I consider it to be so important that I make no apology for having gone over the same ground again, presenting it perhaps from a slightly different angle.

"Haemorrhages can and do occur not infrequently in the retina—usually as the result of an accident—and these are especially marked when there is an obstruction of the retinal vein. They are slowly absorbed, the small one's leaving little or no trace, but the larger haemorrhages may be followed by complications such as glaucoma, vitreous opacities, or detached retina. As I have said, obstruction of the retinal veins results in numerous haemorrhages; stoppage of the blood supply to the retina is followed by oedema, the fundus becoming strikingly pale with narrowing of the retinal arteries. It is an advantage to use the red free filter for such examinations.

"Professor Formston refers to intraocular pressure that develops in the case of glaucoma, but in addition, with the aid of an ophthalmoscope, one should look for a depression or cupping of the disc.

"It is said that this condition is more common in some breeds than in others, for myself I have seen it most frequently in Terriers, but that may be pure coincidence.

"The increased intraocular tension causes a cupping of the disc which will appear to have steep overhanging margins, the veins are distended and the arteries contracted; also, there often appears to be an interruption in the course of the vessels. The disc appears to be pale and in the very late stages, absolutely white.

"Another fairly common condition in sporting breeds is that of detached retina, a condition that would never be diagnosed without the aid of the ophthalmoscope, particularly as it can occur without apparent pain. It can be fairly easily recognised by the detached part of the retina appearing as a grey fold which may move as though floating about, and the darkened blood vessels become tortuously bent. Normally, detached retinas become increasingly worse and total blindness ensues. Of course, there are descriptions in human text-books of the surgical interference to correct this condition and I have seen it referred to in veterinary literature, but I have had no personal experience of the operation and would consider it to be a highly specialised piece of surgery. I have, however, seen one dog, a Greyhound, with a partially detached retina which completely recovered without surgical interference.

"In opening his paper Professor Formston suggested that I might like to enlarge on the subject of hereditary retinal atrophy, but all that is necessary to be said on this condition has, I think, already been published. In any case, the subject has declined in importance these last two or three years, since the Kennel Club legislated on the defect in Irish Setters and it is now seldom met with in that breed.

"All I will say on the subject is that, seen through the ophthalmoscope, the condition presents an appearance very similar to that seen in the blocking of the retinal artery due to other causes. I should like to draw attention, however, to the apparent high incidence of retinal atrophy following virus infections. The Black Labrador seems to have a particular predisposition to retinal atrophy, but whether this is due to an hereditary factor or to some other cause, has yet to be proved.

"Another condition of the retina has been described which appears to be associated with encephalitis, but I have not seen it myself. It resembles the picture seen in progressive retinal atrophy, but apparently differs from it in that a greyish-white reticulum covers the tapetum until eventually it becomes completely hidden from view. Also, over the non-tapetal retina there appear irregular scattered patches of black pigment surmounted by greyish-coloured zones and, in addition, detachment of the retina can often occur.

"Before leaving the dog's eye I should like to refer to a very common condition of the outer eye—the chronic lachrymal discharges that one so often sees in some breeds. This can often be overcome quickly by cauterising the lymphoid tissue on the under surface of the membrane; in my opinion it is the best and quickest way of getting a permanent cure, that is, of course, when the lachrymation is due to a diseased condition of the membrana nictitans which I have found is frequently the case.

"I should like to add a few observations of my own to what Professor Formston has said on the examination of the horse's eye.

"In my opinion it is always advisable, if possible, to see the horse first in its stall or loose-box. Apart from the advantages to be gained in the general examination for soundness, it is very useful to watch the horse's action and ear movements when it is first brought out into the full light, and if there is any doubt it is often a good plan to watch the horse being led back into its box or stall. Under these circumstances, it is often possible to observe some slight indication of defective sight that will be helpful in a more detailed examination later. This later examination can with advantage be carried out after the animal has been tested for wind when the pupils will be dilated. It is helpful to clip the tactile hairs which may easily get in the way when using an ophthalmoscope.

"Professor Formston says in his paper that it is very questionable whether, in either the horse or the dog, a small opacity of the cornea or lens interferes with vision. Generally speaking this may be true, and the importance of such an opacity in the dog's eye is very small, except in the case of the coursing or racing Greyhound. In my opinion, however, any opacity, no matter where it is situated, must be considered seriously in the riding horse. It can, and often does, cause shying or a dangerous misjudgment when jumping, but admittedly it is more dangerous when situated centrally. Perhaps Professor Formston will enlarge on what he means by an opacity.

"Before I close I would like to ask Professor Formston if he would be so kind as to enlarge on the best method of detecting an early cataract in the horse. It is perhaps true to say that the young horse seldom suffers from eye trouble unless he suffers an injury or periodic ophthalmia, but the horse at, say, 10 years or over is quite often subject to cataracts for reasons that are sometimes unknown. Cataracts are often difficult to detect in the early stages and, due to the decrease in the number of horses in use to-day, some of us do not get such frequent opportunities of examining their eyes as we did in the past.

"One other question. Does Professor Formston consider that the large corpora nigra seen in the horse's eye are a handicap to vision, especially when they are situated in the upper part of the iris? And can anyone tell us why they are there at all?

"To sum up, I think the study of ophthalmoscopy is a comparatively new discipline, and there is room for much more work to be done on the subject, especially as regards dogs. Do not imagine that I am decrying the work done by the pioneers of our profession. We owe a debt to Henry Gray for his published literature on the eye, and my late partner Cornish-Bowden had a practical knowledge on the subject, second to none, but that, unfortunately, has been lost to us since no power on earth would induce him to put pen to paper. Most of our information in the past has come from human literature, but recently it would appear that veterinarians are taking a much greater interest in this important and absorbing study. I hope, and believe, we shall have an increase in veterinary literature on ophthalmology. Already we have a recent publication *Veterinary Ophthalmology* by R. H. Smythe, M.R.C.V.S., which I can thoroughly recommend. Here is an opportunity for the profession as a whole; the subject is one that will not develop from research laboratories but from the general practitioner's observations in the field, both from the clinical and surgical aspect.

"Once again may I tender my thanks to Professor Formston, and say how much I have enjoyed his paper."

The General Discussion

Colonel G. V. Short (Wilmslow) wanted to add his quota of thanks to the author for the trouble taken in the preparation of the paper, and to ask him, or indeed any of those present, whether any further information could be given on the various points that occurred in the paper. Mr. Hodgman had referred to the possibilities of retinal atrophies being associated with encephalitis, and Colonel Short had particularly in mind the unilateral retinal atrophy in the horse starting in one eye and almost invariably involving the other eye within a period of four months. In India he had had the opportunity of examining a large number of horses as a routine and that condition was found quite commonly. The brains, optic chiasma and eyes were dissected in one unit and sent to the Imperial Research Institute; all that was ascertained was evidence of cupping down to the optic chiasma along the fibres of the branch to the second eye, but never below the chiasma. In encephalitis in horses, contrary to what one saw in dogs, there was no opacity whatever. A glaring tapetum was usually the first sign. On examination of the eye vision was found to be impaired or it might be totally absent. That occurred in horses that were examined routinely each month.

Could the author say any more on the mechanism of the hypopyon ulcer in the horse, particularly regarding the origin of the inflammation? The schools of thought tended towards thinking the inflammation came from the cornea or the back of the iris. As far as Colonel Short's own experience went it would seem that the inflammation arose in the ciliary bodies of the eyes. Pus could collect between the iris and the lens and spill over into the anterior chamber, and there followed the familiar train of symptoms. Had the author experience of miducaine injected subconjunctivally and would he consider iridectomy in such eyes? Also, had he used miducaine as an aid to diagnosis for what had been referred to as early cataract in the horse?

On the subject of ophthalmoscopes, it had been mentioned that the ones with batteries in the handle were most useful, but they all had experience of the substandard battery ophthalmoscope. It was not as a rule fitted with a fibrous cuff to take the batteries and guard against corrosion and damage to the handle. If it was put away for a couple of months in a moist climate a corrosion resulted which must be dissolved before the instrument could be used again. Could some indication be given of the use of an instrument one never seemed to hear of now, a tonometer, and what was the author's opinion on sclero-puncture and the relief of glaucoma?

Miss O. Uvarov (Cobham) wanted to thank the author for the paper and Mr. Hodgman for discussing it in such a thorough manner. They owed Professor Formston a debt of gratitude for attempting to describe and discuss the use of the ophthalmoscope. Probably the majority of them were never taught very much about the use of the ophthalmoscope and either did not use it or discovered its uses accidentally. Once the ophthalmoscope was discovered, however, it became a most exciting instrument in the equipment of the surgery.

As there seemed to be so little discussion on the anatomical aspect of the examination of the eye, might they deviate from the title of the paper, if there was time, and ask the author and Mr. Hodgman to discuss the use of ophthalmoscopy for the diagnosis or description of eye changes in certain hypertensive diseases of the dog? What type of changes in the eye were found by them in the dog suffering from chronic nephritis? Although the descriptions were adequate for human ophthalmology

or urology, they were not for the canine species. It would be interesting to hear whether the haemorrhages the author referred to became chronic.

If there was sufficient time would Professor Formston enlarge on the use of cortisone in the treatment of eye diseases? He had done a lot of work on it, which was not published, and they might be able to extract a lot of useful information from him.

Miss Uvarov said that, in view of the absence of contributions she would like to make an unusual request. There was someone in the audience who was not a veterinary surgeon but who had observed an interesting case of changing appearance of a horse's eyes. The person concerned was Mrs. Hodgman, and it would be interesting if they could share her experiences. (Applause.)

Mrs. S. F. J. Hodgman, having been invited by the Chairman to speak, said she would like to refer to a curious happening that came under her personal observations when she was 17. In India she had played a lot of polo and on one occasion borrowed a polo pony. The reason for the animal being lent was that it suddenly refused to play for a man. The pony played beautifully for her throughout a season and then its temper began to change. It was a lot of trouble to put the saddle and bridle on, but once on the polo ground the pony would always play. Then one day, when the pony was in its box, it suddenly turned round and its eyes appeared to be like enormously magnified panther eyes, quite green. It was a most uncanny sight.

Mrs. Hodgman asked Major Oliver, who was stationed at Lucknow at the time, to look at the pony, and he agreed to do so. Major Oliver, on seeing the pony, asked whether it was playing well or as if it were slightly blind. It had in fact been noticed that the animal would shy when another player came near. The condition did not improve and eventually the pony went blind completely in one eye. After the pony was destroyed Major Oliver opened up the skull and a large growth was found inside the brain, which he kept at his hospital in Lucknow for a long time as a sort of show-piece.

Colonel G. V. Short said he could refer to the very specimen Mrs. Hodgman had mentioned because he had seen it at the very first hospital he went to on being posted to India. The exhibit was preserved by Major Oliver in spirit. The growth had caused pressure from behind on both of the frontal lobes.

Mr. F. V. John (Llandilo) asked whether he might go outside the scope of the paper to seek information on a condition seen in young bulls. It was manifested by the sudden onset of blindness at about puberty, the age of 10 months or a year. A friend who was an eye specialist said the cases, which he had seen with Mr. John, corresponded with Lieber's disease in the human male, which also appeared at about the time of puberty, and was accepted as hereditary. The important point would seem to be associated with bull licensing because Mr. John was told that at the moment the only grounds for refusing a bull licence was blindness from birth. If the condition referred to was hereditary the matter was quite serious and the licensing rules should be amended to include it.

Professor Formston, in reply, thanked Mr. Hodgman for letting him off so lightly and for contributing so much to the general aspect of the paper. It was perhaps a paper which did not lend itself to enthusiastic discussion or controversy because it had not dealt with disease aspects of the eye. In his opinion it was exceedingly important when examining horses for soundness that the eyes should be examined carefully for cataract, and if it was present it should be regarded as a serious unsoundness. On the other hand, he believed that the seriousness lay in the possibility of involving more and more of the lens in the course of time. Provided it remained localised and small he did not think it caused any visionary inconvenience to the horse. Cataracts in the dog, so long as they were not complete and mature, appeared to have little or no effect on the animal's sight. He did not think it was difficult to detect an early cataract in a horse by first examining the eyes with the horse standing in a diffuse light and then, if one was suspicious, by using the ophthalmoscope. Most cataracts in the horse were more or less central in position and it was seldom or never that dilatation of the pupil with homatropine was necessary.

When using repeated instillations of atropine into the horse's eye one had to remember that the effect would persist for some considerable time—10 days or more—after the cessation of treatment and it was as well to inform the owner of this. Professor Formston thanked Colonel Short for his remarks. He had not encountered hypopyon in the horse as the result of corneal ulceration. He had only seen it in connexion with horses with periodic ophthalmia. On the other hand, deep ulceration of the dog's cornea frequently produced a hypopyon and indicated the necessity for an immediate paracentesis otherwise perforation would occur. Adhesions between the iris and lens occurred very readily in the horse but not so in other species. One must remember that the horse differed from most of our patients in that it was particularly prone to oedema, and he felt that the surprising rapidity with which a synechia occurred in iridocyclitis was a local manifestation of this phenomenon. It was therefore necessary to employ atropine therapy at the earliest possible moment to dilate the pupil and thereby remove the iris from intimate contact with the lens, and also to put it out of a state of spasm.

He had found atropine adequate as a mydriatic. "Mydricain" had to be given by subconjunctival injection—not always a simple procedure—and although it contained cocaine he had found when used on the dog that it was not always free from pain. Iridectomy or separation of the iris from the lens in synechia was fraught with many hazards not the least being haemorrhage. He thought such interference was unrealistic in the horse because in any case if separation could be effected it would be of little value on account of the degenerative changes in lens, choroid and retina which invariably result from attacks of periodic ophthalmia if severe enough to produce a synechia.

Intraocular pressure could be measured with some degree of accuracy with a tonometer as used in man. He felt however that digital assessment was adequate in animals. One could, with a little practice, easily appreciate the difference between a normal eye and one in which there was increased pressure. An increase in the size of the eyeball did not necessarily go hand in hand with increased pressure; often it resulted in hypotony. It was his view that glaucoma in animals was usually of the secondary type and in the dog was almost invariably due to lens luxation. Consequently it was questionable if corneo-scleral puncture was of value. Good results could sometimes be obtained by cyclodialysis if one could adequately open up the supra-choroidal space.

Passing to Miss Uvarov's contribution, Professor Formston said he would hate to say he could diagnose chronic nephritis in the dog from examination of the fundus. On the other hand, in known cases of chronic proteinuria one can, without much difficulty, detect a retinitis with marked distension of the retinal veins. A reliable guide to the degree of anaemia could be obtained by examination of the vessels of the fundus. Cortisone was an agent which controlled or negatived inflammatory processes and therefore it must not be used indiscriminately. There were occasions when inflammatory reaction was excessive, too prolonged, or apparently unnecessary; for example, periodic ophthalmia in the horse and a chronic vascularisation of the cornea in the dog. In an agreeable percentage of cases, particularly in the dog, cortisone applied topically in the form of a 2 per cent. ointment had produced excellent results. It may be imaginary but he thought that he was seeing many more cases of pannus in dogs and he thought they were not unassociated with previous protracted instillations of antibiotics.

In answer to Mr. John he said he was of the opinion that blindness in cattle was probably on the increase. It was mainly confined to Channel Islands breeds, and whilst the blindness was associated with poor vitamin A storage and constriction of the optic nerve at the optic chiasma,

other factors, probably hereditary, had been brought to light as the result of breeding experiments at present proceeding. His attention had been drawn to blindness in bull calves of another popular breed. It was his opinion that most of these bulls were blind very much earlier than one year but were not noticed.

He thanked the meeting for its discussion. (Applause.)

The Chairman, Major F. Chambers, said he would like to thank the speakers particularly because the paper was not one on which a really acrimonious discussion could have been expected. It had been enjoyable to listen to the contributions and he wished to thank Professor Formston and all those who had spoken.

Poultry Breeding for Increased Production, with Special Reference to Health

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THE poultry industry expanded rapidly after the first world war, both in the number of fowls kept and in efficiency, and to-day its annual output represents over 10 per cent. of the total agricultural income. Poultry farmers have always taken a great interest in scientific research, and the progress made has largely resulted from the practical application of the results of scientific experiments. To-day, egg production is becoming increasingly regarded as an important part of general farming. It is being taken up seriously by many farmers whose predecessors kept only a few fowls round the farm yard. However, as the costs of egg production are steadily rising, it is becoming more and more difficult to obtain an economic return from keeping laying fowls, and greater attention is being focused on methods of increasing efficiency and reducing costs. The main way in which efficiency can be increased is by raising the level of egg production, but, as price variations favour winter egg production, and make spring production barely profitable, it is necessary to increase the proportion of eggs laid during the high-price period, as well as to increase the annual output. This means that poultry breeding has to be carefully planned, for winter egg production is unnatural. A wild hen lays about 40 eggs a year in the spring and summer, and broods them and rears the chicks herself. Her domesticated descendants are expected to produce about five times as many eggs, and to lay throughout the whole year, while broodiness has become a crime. This change, from hens which laid in spring only to birds which will lay well in winter in addition, is a big one.

Success in breeding really fine individual hens is relatively common, for more than 10 per cent. of the birds entered in American laying tests in the last few years have been recorded as having produced over 300 eggs in 51 weeks of the first laying year (Du Plessis, 1954). Yet there are very few flocks in which the good qualities of these individuals are transmitted in regular fashion. We cannot yet obtain 300 egg flock averages, and are still looking forward to the egg-a-day breed of fowls, and further still to the production of hens having two functional ovaries and oviducts and the development of a strain producing two eggs a day. Although in this paper attention is being paid mainly to the numbers of eggs laid, it must be appreciated that there are other factors of importance in breeding fowls for economic egg production, such as efficient food conversion, the maintenance of egg size, rapid feathering, minimum broodiness and high hatchability, which breeders have to take into consideration as well.

On most farms it is difficult to reduce the cost of production. The cost of the food is the major individual item, and in most cases this can only be decreased by lowering the quality of the diet, and this is usually a false economy. Labour costs are generally considered to make up about 10 per cent. of the total, and attempts to counteract rises in wages by increasing the number of birds a man can supervise are justified to some extent by the use of labour-saving methods of management; but if this is overdone there is a risk of reduction in egg yield and in the health of the flock. One cost which could be reduced is the annual depreciation of the laying flock during the first laying year by a reduction in the mortality rate. An increase in liveability would effect a reduction even on those farms where the mortality rate is not abnormally high, and it would make an appreciable saving on many farms, for the high death-rate is one of the major causes of loss in poultry keeping to-day.

Gordon (1953), referring to the results of the Poultry Production and Progeny Trials, records that the percentage mortality rate from day old to point of production was 4.5, 2.06, and 6.4 during three consecutive years. During the subsequent production period of 48 weeks the percentage mortality over the same years was 20.1, 16.8, and 17.5. Thus the percentage mortality from day old to the end of the first laying season ranged from 18.8 to 24.6. He has, however, pointed out that the mortality rate throughout the poultry industry as a whole must be greatly in excess of these figures, for heavy losses are caused by infections such as pullorum disease, salmonellosis, fowl typhoid, coccidiosis and other parasitic diseases, respiratory infections, deficiency disorders, and other conditions which did not contribute to the deaths on which these records were based. When considering the causes of poultry mortality it is obvious that the avian leucosis complex and the fowl paralysis group of diseases are together the most important causes of death. In the mortality record of the Lancashire Poultry Production and Progeny Trials, Gordon (1955) showed that the avian leucosis complex and neurolymphomatosis accounted for 23.8 per cent. of the mortality during the first laying year in the parent pens. He also showed that during the progeny production period these conditions accounted for 47.7 per cent. of the total losses.

Breeding for Disease Resistance

In view of the great importance of disease in the economics of poultry husbandry it might be considered that selection for disease resistance should be practised. There is no doubt that some strains or breeds of poultry are particularly susceptible to disease. Some years ago certain strains of Leghorns

were bred and selected for laying large numbers of big eggs without any attention being paid to the body size of the birds, and about half the pullets died of eversion of the cloaca during their first laying year. The birds which survived were, in many cases, very good layers of large eggs, but the high mortality rate made use of the strain uneconomic. In such an extreme case selection for families which did not have such a high mortality rate would be justified.

It has been very clearly demonstrated by research workers, notably by Hutt & Cole (1944) and Coles (1955), that it is possible to breed strains of poultry with a marked degree of resistance to leucosis, but it is not feasible to use this method for commercial poultry breeding for very few poultry keepers would be in a position to provide the necessary exposure to the disease needed to test the resistance of the strain. In addition, in the economics of poultry husbandry, disease is important as a cause of financial loss, and selection for disease resistance primarily could easily result in a strain of poor, and therefore unprofitable, layers. Coles (1955) has drawn attention to the higher incidence of lymphomatosis among the progeny of dams having a higher fertility and hatching rate of fertile eggs than their pen sisters which did not have progeny succumbing to the disease in the same season. From figures relating to five seasons it was apparent that both fertility and hatchability of fertile eggs were higher each season with those dams in whose progeny deaths from lymphomatosis occurred over the first 18 months of their lives. The difference in the hatching rate of all eggs set between the two groups was statistically significant at the 1 per cent. probability level. Thus, although an inherited natural immunity to a prevalent disease, such as leucosis, would be of enormous importance, it is so essential that birds are profitable layers that selection for egg yield must be the primary consideration. However, every endeavour must be made to maintain a high standard of constitutional vigour, and birds lacking in vitality must not be used for breeding. If a breeder allows egg production records to induce him to breed from birds that lack stamina he can expect a high death-rate among the progeny.

Poultry breeding methods fall into two classes—those adopted by the breeders of pure-bred stock, which will be used for future breeding, and those employed by breeders who are producing pullets which will be kept for laying only, and will not be used for breeding.

Breeding Pure-bred Stock

The methods employed by breeders of this class of bird depend on selection for merit. With egg production such selection leads to a slow rate of progress, which becomes progressively slower and slower with each succeeding generation as the higher levels of production are attained. One method used is to select the best layers and mate them to the sons of the very best hens. The results are often disappointing, for the daughters of good hens prove to be poor layers, whereas the daughters of poor hens are surprisingly good. This indicates that the good or poor quality of the birds depends to a large extent on uninherited environmental factors and that the hens selected because of their high egg production were not of a better genetic make-up than the average of the flock from which they were taken.

To produce a superior strain in-breeding to an outstanding bird is sometimes practised, birds closely related to the superior individual being mated together. By in-breeding generation after generation the potential variability of the strain steadily diminishes, and it is often possible to use this system of breeding to great advantage in making the majority of the birds pure for the inherited make-up of the exceptionally good foundation bird. However, as the strain becomes pure, it does not only become pure in respect of the characters valued, but in other respects as well. Thus in-breeding greatly enhances the possibility of producing undesirable birds lacking in size and vigour, with an increased susceptibility to disease and lowered fertility. Strict selection is necessary to direct the trend of in-breeding towards the desired goal. The use of any but the best and strongest birds must be avoided, and weak individuals must never be used. Most faults are recessive and it it easy to get them fixed in a strain. In-breeding is a powerful tool, but it can be a dangerous one.

Line-breeding, or the mating together of distantly related birds, is the system of breeding which has been favoured by some of the most successful breeders for many years. The aim is to maintain a relationship within the strain to some superior individual. It is justified if an outstanding bird has been produced, providing its best progeny only are used. All line-breeding involves a degree of in-breeding, and thus some weak birds are produced. The health of the strain is maintained by the recognition and elimination of all undesirable individuals, and this ability to cull ruthlessly is an essential qualification for a successful breeder.

Breeding Cross-bred Stock

In breeding birds for commercial egg production the aim is to produce hardy stock that will lay well during their first year, and matings designed to produce commercial replacements are generally of unrelated birds. By using pure-bred stock of strains bred for high egg yields the rate of gain in egg production in a generation can be greatly increased. The crossing of unlike strains or breeds generally results in offspring with increased stamina, this phenomenon being known as heterosis or hybrid vigour. It may be expressed in a number of ways, including a higher egg yield, lower mortality rate, a faster and more efficient growth rate, and a lowered susceptibility to environmental errors. The genetic reason for heterosis is not known with certainty, but two of the probable reasons were given by Rice, Andrews & Warwick (1953). As a species or a breed develops it becomes homozygous for some dominant favourable factors, and probably also for some unfavourable recessive ones. Another breed or species would probably not be homozygous for the same undesirable recessive genes, and if the two were crossed the effects of the undesirable recessive genes would be masked. Another possible explanation is that the heterozygote

is genetically more vigorous than either homozygote, and this is spoken of as over-dominance. It is probable that heterosis is due in part to the superiority of the heterozygote and in part to the presence of favourable dominant genes.

Nicking is an additional advantage which can result from the crossing of two breeds or strains. Two strains are said to nick if birds of each strain when mated together produce progeny superior to either of the parent strains. It generally occurs when one strain excels where the other fails—for example birds of a strain excelling in egg yield, but failing in egg size, when mated to birds of a strain which lay a small number of large eggs, may produce progeny which give a good yield of large eggs.

Heterosis and nicking have been utilised in poultry breeding for many years for the production of laying fowls. For example excellent commercial birds are produced by crossing such breeds as the Black Leghorn and the Rhode Island Red, or the Rhode Island Red and the Light Sussex. The resulting progeny are good layers, uniform in type with an absence of weaklings, and have a low mortality rate; but if such cross-bred birds are used for breeding, their offspring will be very variable in quality, with a number of inferior individuals, so that the average quality will be low. In the past most breeders have used their pullets or their inferior stock for the cross-breeding and have reserved their best birds for the production of pure-bred stock, but in view of the importance of the quality of cross-bred pullets to commercial farmers to-day, a great deal of attention is being given to the production of high-quality cross-breds.

The term " hybrid " in its simplest form is applied to any progeny resulting from cross-breeding, but the word as now used in relation to poultry breeding has no clear-cut definition. Many breeders use it only for birds produced by crossing carefully selected breeds and strains which have been proved to produce progeny superior to their parents, and do not apply it to the offspring of every first cross. Mann (1956) considers that the essential features of hybrid fowls are that they must have been produced by combining two or more foundation stocks which " nick " when mated, and that the ability to " nick," as estimated by the performances of the progeny, must be exhibited by the parent stocks as a whole. Two methods being used for the production of cross-bred birds of uniformly high quality are reciprocal recurrent selection and in-cross-breeding.

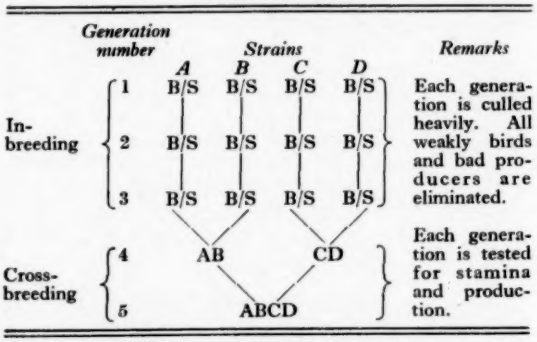
Reciprocal recurrent selection

This method has been developed to utilise heterosis and nicking for the production of superior hybrids. The fowls being used for this method of breeding are divided into two separate flocks, which can be designated A and B. These flocks usually consist of birds of different breeds, but they can be of two different strains of the same breed. In the first year the males of flock A are mated to the females of flock B, and vice versa. Only one cock is run in each pen, and the hens are trap-nested so that both parents of all the progeny are known. In the second year the majority of the birds are sold for commercial egg production, but some of the progeny from each hen are tested, and the records of the daughters from each individual cock and hen are considered. The A males giving the best cross-breds are selected and mated to the A females which produced the best cross-breds. Similarly the most successful B males are mated to the best B females. These birds are used to reproduce the pure stocks, and in the fourth year cross-matings between these birds are made, and their progeny tested in the same way as those from the original birds in flocks A and B. In subsequent years the alternation of progeny-testing and the production of parent stocks is repeated. By this method the birds producing the best cross-breds when mated to birds of the other strain or breed are selected. These are not necessarily the birds which would give the best results when used for producing pure-bred stock. The advantages of this system are that no in-bred strains are required and that it can be operated on a reasonably small scale.

In-cross-breeding

This system has been designed to obtain the advantages of heterosis, nicking, and in-breeding. At least four in-bred lines are produced from good-quality stock. The aim is to make them as genetically uniform as possible, and to eliminate undesirable recessive genes. To obtain the in-bred lines as rapidly as possible brother to sister matings are employed. When these in-bred lines have been established they are intermated in as many combinations as possible, and those which give the best two-way crosses are retained. These are then mated together to produce four-way crosses, and the birds so produced are used for egg production commercially. The system is efficient, but the initial expense of producing the three generations of in-bred birds is great.

IN-CROSS-BREEDING



Note.—B/S indicates brother to sister mating.

If the ABCD birds prove satisfactory they are produced in large numbers for sale to commercial egg producers.

In the production of hybrids, whichever method is employed, the effect of heterosis is the main safeguard against a high incidence of disease.

Breeding from Pullets

In the production of hybrids, and, to a lesser extent, in the breeding of pure-bred stock, the drive for

higher egg yields has been accompanied by an increasing use of pullets for breeding, although poultry breeders are generally of the opinion that it is better to breed from hens as opposed to pullets on the assumption that if a bird is not bred from until its second year it has, at least, shown its ability to live for that length of time. Hays & Spear (1952) have shown that chicks hatched from pullet eggs show a higher mortality rate than those from hen eggs. Many breeders also hold the view that hen-bred pullets are more resistant to lymphomatosis. This theory has the support of Kennard (1933) who found that the mortality from neurolymphomatosis in hen-bred pullets was about half that of pullet-bred pullets. The same findings were reported by Gildow, Williams & Lampman (1940). On the other hand the breeders who regard breeding from pullets as unsound practice have no objection to breeding from cockerels, and it is illogical to suggest that breeding from pullets is unwise, while breeding from cockerels is a commonly accepted practice (Robinson, 1947). Uncontrolled breeding from pullets is undoubtedly undesirable, for it would mean that the progeny of birds that die in their first year might be used for breeding, and there would be a tendency to produce a strain having low liveability. It appears, however, that breeding from selected pullets under control, so that the progeny of birds which die can be discarded, can be adopted safely.

Progeny Testing

In the past, great attention has been paid to the selection of the individual birds used for breeding, but it has now been established that the family history of the birds must be considered if a strain of hens giving a high average yield and showing a low mortality rate is to be established. The only way of judging the quality of a breeding bird is by assessing its success in producing good progeny, and so a method of progeny testing is an important feature of any system of poultry breeding.

Progeny Testing is employed by the breeders of pure-breds to assess the quality of the stock produced by individual birds; by commercial breeders to test hybrids; and by the Ministry of Agriculture, through an official plan, to estimate the quality of the stock being produced by certain breeders in the Accredited Poultry Scheme.

The Progeny Testing systems used by the breeders of pure-bred stock can be classified into two kinds—those that take into account the quality of the females used and employ daughter-dam comparisons for judging the sire, and those which leave the dams out of consideration. In poultry breeding the latter plan is almost always adopted, and Hagedoorn (1950), who made a study of the subject, was convinced that the best test of the breeding value of a sire is the average quality of its daughters, providing unselected groups of daughters are taken. A bird cannot be progeny tested unless its offspring from several mates are examined, and this means that it is relatively easy to test cocks, but practically impossible to test hens. Cocks are mated to about 10 hens and at least 20 daughters from each are kept. These can be individually trap-nested, but, as it is the average production of all the daughters that is required, it is sufficient to record the total number of eggs laid by all the daughters. The cock that is wanted is the one which produces daughters giving a high average production—not the bird which produces a few superior daughters only, however good these may be. To obtain a true picture of a cock's merits it should be used for one season to produce daughters for testing, then rested or used for commercial breeding during its second season while its progeny are laying as pullets, and then used extensively in its third and subsequent seasons if the progeny test warrants it. This system gives a true assessment of the bird's worth; but, if a number of cocks are being tested, it is not always possible to use them all for cross-breeding, and so some, or all, have to be kept without being used for a year. They have to be housed individually to avoid fighting and most breeders keep each cock in a small house with a small run attached. It has been found that a few birds so kept are infertile when needed in their third season, and this risk appears to be avoided by running each cock with three or four pullets during the second year.

This period of one year in which a cock has to be segregated is highly inconvenient and to avoid it many breeders are taking pullets hatched in December or early January and are using them for progeny testing. These birds come into lay about July, and by December of that year have demonstrated their rearability, and have, at least, given an indication as to their powers of egg production. If a number of cocks are being tested it at least gives an indication of any which are certain to be unsuitable and means that these can be eliminated. Those cocks which give good results when tested in this way are used during their second season, although there is always a chance that some defect unrevealed by this short test may appear, and this would necessitate the discarding of the cock and all its progeny.

Progeny Testing is an integral part of hybrid breeding, and birds of most successful lines can be easily reared and prove very good layers. Thornber (1956) records the results of the B.O.C.M. 1955-56 500-Day Random Sample Trial where deliberate and heavy exposure to fowl paralysis was a basis of the test. From 0 to 160 days the mortality from leucosis among the 15 entries each comprising 40 day-old pullets varied from two to nine birds per team with an average of 10.8 per cent. with the exception of a team of hybrids which had no mortality through this cause. This does not, of course, prove that all hybrids are resistant to leucosis, but shows that certain hybrids have greater resistance than the average.

As the performance of the stock bred is the only true way of assessing the skill and success of a breeder, from October 1st, 1956, a new section is being started in the Breeders' Grade of the Ministry of Agriculture Poultry Stock Improvement Plan, known as Class A, in which breeders must send birds to a testing station to be progeny tested. One hundred eggs, selected at random by the Ministry's Poultry Advisory Officers,

are incubated, and a random sample of 15 pullets taken and housed in semi-intensive pens equipped with trap-nest houses. The breeder must send two cocks, selected by himself, and these are mated to the 15 pullets on alternate days. From the progeny a random sample of 25 pullets are housed under built-up litter management, with lights when appropriate, and the production of eggs recorded over 48 weeks. A score basis has been devised which includes marks for the hatching rate of all eggs set, the rearability of the pullet chicks to five months, and the total egg production of the 25 pullets. Each complete test period takes about two and a half years.

Egg production appears to be firmly established as a part of the agricultural production of this country. If the poultry industry is to maintain and improve its position in our national economy it is essential that there should be a continued improvement in the quality of the poultry kept for laying. Hens must be bred which have the genetic make-up and the physical stamina necessary for high egg production with a low mortality rate. The responsibility for the production of such birds rests mainly with the poultry breeders, for they, to a very large extent, supply the laying birds kept in this country. A good breeding programme can, therefore, contribute to the financial success of the poultry industry, directly by ensuring a good egg yield, and indirectly by keeping down losses from disease.

This fitting tribute to the bird, whose breeding has been considered in this paper, was written by Herford and quoted by Coles (1951):—

> Alas! my child, where is the Pen
> That can do justice to the Hen?
> Like Royalty she goes her way,
> Laying Foundations every day,
> Though not for Public Buildings, yet
> For Custard, Cake and Omelette.
> Or if too old for such a use
> They have their fling at some abuse . . .
> No wonder, Child, we prize the Hen,
> Whose Egg is mightier than the Pen.

Summary

As the costs of egg production are steadily rising, great attention is being paid to methods of increasing the efficiency and reducing the cost of poultry keeping. The main way in which efficiency can be increased is by raising the level of egg production, and one cost which could be reduced is the annual depreciation of the laying flock through a reduction in the mortality rate.

Breeding for disease resistance is a practical possibility, but, as selection for disease resistance primarily could result in a strain of poor, and therefore unprofitable, layers, it is not recommended.

The methods employed by breeders of pure-bred stock to produce superior strains include in-breeding and line-breeding. Cross-breeding is used for producing birds for laying so as to obtain the increased vigour resulting from heterosis. Nicking is an additional advantage which can result from the crossing of two breeds or strains. Two methods being used for the production of cross-bred birds of a uniformly high quality are reciprocal recurrent selection and in-cross-breeding.

Pullets are being increasingly used for breeding in the production of hybrids, although there is evidence to show that the mortality rate is higher in pullet-bred than in hen-bred pullets. However, breeding from selected pullets under control, so that the progeny of birds which die can be discarded, can be safely adopted.

Some method of progeny testing is an important feature of any system of poultry breeding. It is employed by the breeders of pure-bred birds to assess the quality of the stock produced by individual cocks; by commercial breeders to test hybrids; and by the Ministry of Agriculture, through an official plan, to estimate the quality of the stock being produced by certain breeders in the Accredited Poultry Scheme.

A good poultry breeding programme can contribute to the financial success of the poultry industry, directly by ensuring a good egg yield, and indirectly by keeping down losses from disease.

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THE SPEAKER'S INTRODUCTION

The Chairman (Mr. E. G. Morris) said they had come now to the last formal paper of the Congress. Although it was the last they would agree it was by no means the least. The Committee which decided the papers had set Mr. King a very big task indeed. The title of his paper was " Poultry Breeding for Increased Production with Special Reference to Health," and if that meant anything it meant increased production and better health. If anyone could solve the problems connected with those two questions in the short space of time that Mr. King had at his disposal he would be a genius.

The third sentence of his paper stated, " To-day, egg production is becoming increasingly regarded as an important part of general farming." The Chairman wanted to emphasise the last two words—general farming. The agricultural returns for June 1956 showed that the poultry population of England and Wales now amounted to 72 millions. At the Torquay congress Gordon calculated that the loss from disease in the poultry industry of this country amounted to over £20,000,000. If those three points had not got a very definite meaning for the veterinary profession he did not know what had.

To introduce the brains which were going to handle the subject: the paper had been written by Mr. J. O. L. King, Senior Lecturer in animal husbandry at Liverpool, and they welcomed him very sincerely. There were two openers, to be introduced in order of their performance and not in order of their importance! Mr. Belfield, the first opener, was head of Sterling Poultry Products, Ltd., a breeder of great experience and an original member of the Minister's Poultry Stock Improvement Council. They very much looked forward to hearing Mr. Belfield's comments. The second opener was Miss E. E. Kidd, President of the Chick Producers' Association. Miss Kidd was also an original member of the Minister's Stock Improvement Council. Many tributes had been paid to her great experience and wisdom in the complicated problem of chick production.

The paper would now be introduced by Mr. King. (Applause.)

Mr. J. O. L. King said that first of all he would like to take the opportunity of thanking the Committee which had organised the Congress for the honour they had bestowed upon him in asking him to present a paper to the profession on poultry breeding. The fact that time was made available for such a paper, when a great variety of topics could be considered, was an indication that the veterinary profession was taking an interest in the work of the poultry industry.

Those who had read the paper would realise that it was written in a very simple and straightforward style. That was done purposely in the hope that it would be of interest to all those members of the profession who came in contact with poultry farmers during the course of their work. Those who were specialists in poultry would find the paper rather elementary fare for that reason.

They were fortunate in having two such eminent members of the poultry industry with them to open the discussion. From their vast experience they would be able to start a discussion which would be of value to all.

It was hoped that during the discussion it would be remembered that the poultry breeder to-day had to consider a very large number of economic factors, of which reduction in the incidence of disease was only one. Some factors, such as egg size, egg shape and shell quality, were directly related to health because they influenced hatchability; but others, for example efficient food conversion, were not necessarily related in any way.

Mr. King said that he was looking forward to a very good and interesting discussion. (Applause.)

The Openers

Mr. G. G. Belfield (Sterling Poultry Products, Ltd., Salisbury): "I agree with your Chairman that the Committee has asked Mr. King to do very nearly the impossible in dealing with such a subject as this in a short paper. The only other king who attempted such a thing was I think called Canute, and I imagine he did not have such a large audience as is here to-day. In discussing this very able paper by Mr. King (because he has gone over a tremendous lot of ground in a very short space of print), I would say I think he has done very well because he has found room even for a very nice neat couplet. I shall not recite it; I was tempted to give my own version of it but I thought I had better not.

"The first point I should like to discuss is the one of economics because Mr. King very rightly lays great emphasis on this, and I am a commercial breeder who has to supply vast quantities of day-old chicks to those people who produce the eggs which you eat and those people can stay in business only if the birds I produce are economical. Mr. King very rightly says that the number of eggs laid is the vital factor. In my breeding work, with all the very many various methods of selection I have tried and used, and with the tables I have formed in conjunction with the best geneticists and brains available, the hen-house average always swamps every other factor Mr. King has mentioned. The model type of bird people want for the production of eggs economically is fairly well defined.

"Mr. King mentioned the various side factors, such as body size, quick feathering, food conversion. If one gives due attention to these factors then the type of bird one is trying to breed is fairly clear-cut. It is not quite so easy in detail because to-day the marketing of eggs is in the melting pot and possibly it pays to produce a lot of small eggs, whereas, as a breeder, I have to look at least five years ahead and I am hoping that eventually you and the people who consume the eggs will ask for a decent sized egg, and breeders will once again produce it. To-day a large output of quite small eggs pays handsomely.

"Having dealt with the economic side of the question very briefly, I think I should like to agree with Mr. King again—it is rather peculiar to open a discussion by agreeing with everything the author has written—because he does mention leucosis as a chief robber of profits for the commercial egg producer. The different forms of leucosis are the number one burglarman who steps in when the poultryman has spent his money on his pullets and instead of their producing eggs they fall down and die.

"I am terribly disappointed that in this admirable paper Mr. King gives us so little hope and guidance. He says: 'Every endeavour must be made to maintain a high standard of constitutional vigour, and birds lacking in vitality must not be bred from.' I should like to ask how that helps the modern poultry breeder, because it is surely just the thing we have been brought up on and everybody worthy of the name 'breeder' tries to do just that. I do not know whether Mr. King has got a special method of finding out whether a bird is of wonderful constitutional vigour and vitality among a flock of high-producing birds with a high hen-house average. Is a bird lacking in constitutional vigour if it dies of leucosis or if it is killed by the Ministry because of fowl pest? I am just left where I was 20 years ago when it comes to the question of judging vitality and constitutional vigour in a flock made up of different lines and different families all of which are high producers.

"Mr. King deals with inbreeding, which is one of the tools breeders use in trying to produce a superior bird, and again he stresses this constitutional vigour. My experience over 10 years of the mating which he quotes, s.i.b. matings, shows me that this selection or this culling for constitutional vigour is automatic, and I think that is one of the advantages of this method of breeding. There again, I do not know if Mr. King advocates culling individuals or whether he would say you should cull the whole line or family. My experience shows this culling is done far better than I can do it by inbreeding, and many lines will completely eliminate themselves.

"In dealing with heterosis, I think it is rather a pity, and maybe it is inexplicable, that one of the crosses Mr. King quotes (*i.e.* Black Leghorn x R.I.R.) gives more trouble to my firm and friends in the industry from leucosis or paralysis than any other cross that is produced by commercial breeders. When I consider that 85 per cent. of my production of something like 12 million chicks a year is in first crosses and hybrids, I think it is a natural corollary that one should take very careful pains in making first crosses and recapturing this heterosis, but at the same time try to deal with paralysis, leucosis, or call it what you will in the professional terms.

"Mr. King follows on with: 'The best way to do this is with recurrent reciprocal testing.' I think it may be a wonderful way of doing it. I am sure there is no breeder in this country who has done it long enough to say whether it is any good or not—there may be one or two in America who think they are in the right lines—but I am quite sure that some form of reciprocal testing, if one is trying to make superior first crosses, is essential.

"I suppose one of the tools the breeders use, one of the oldest and one of the most up-to-date because it has been given the name only quite recently, is progeny testing. Mr. King says it is relatively easy to test cocks but practically impossible to test hens. If he had said it was equally difficult to test cockerels and hens I would have agreed with him. I do not think it is more difficult to test hens by a method of triple matings than it is to test cockerels, and I think Mr. King has rather more faith in the use and longevity of cocks than I have, because in my experience if you do not reckon on losing half your male birds before you have to test results then that part of your work is

wasted. On the other hand, the hen, I know, is a very modest factor in a large-scale breeding programme, but she is easy to handle, she lives longer and she is profitable. I rather deprecate this statement that you cannot test hens but it is quite easy to test cockerels. I think it is difficult to do either. It is not difficult actually to test but environment plays such a tremendous part in the results you get. It is so easy to think you are testing a genetic improvement and you are only testing the differences in environment. I think the question of environment for anybody doing tests is quite as important as the methods you use in selecting any one or all of these methods Mr. King has outlined.

" I must have a little rub about the horrible diagram on ' in-cross-breeding.' It is I think a little horror because diagrams are fine on paper but not always if you put them into operation. In some of the colleges—mostly in America —which do these experiments they never go wrong. Here is six years of most intricate work put into three columns. I have tried some of them. In the margin on the right-hand side it says ' Each generation is culled heavily.' I have already told you my experience of inbreeding and how the birds will cull themselves. But what does Mr. King cull when he is working to this diagram over six years? Does he cull individuals or whole lines and what basis does he use? When one is inbreeding one gets a gradual deterioration in standards. Do you deteriorate in methods of culling or judge from a lower standard for each generation, or how do you tell which birds have got vitality?

" There are two bugbears I have in mind as a commercial breeder on a fairly large scale. One is that I have to try to keep in step with the Ministry and their Stock Improvement plans, and I am wondering whether Mr. King thinks the new Stock Improvement plan for breeders is in line with modern thought, and will it help to produce disease-free or disease-resistant stock? I speak with great diffidence here because you are the experts, but, as I see it, most of our serious troubles belong to the virus group.

" I know nothing about viruses—I am sure *you* know all about them—but if I understand modern thought it seems to lie in the direction of immunisation and vaccination for such things as poliomyelits, and yet in poultry stock and other live-stock destruction seems to be the official policy. What use is it for anybody to tell me to breed for disease-resistant strains? It seems to me it would be a complete waste of money. During the last 21 months I have suffered the elimination of a very large part of my breeding stock from the official policy of slaughter for fowl pest, and I do not care what anybody says, I know those birds had pretty good vitality. The same thing applies to salmonella infections. One is not allowed to breed for resistance and I think the breeder would be stupid, even if it were possible to breed for resistance if he is trying to keep within the lines of official policy.

" In the testing of stock what standard should one set? One tries to have a standard environment. Should it be a normal environment, sub-normal or the best possible? When I talk about environment I mean management and feeding and all that goes with it, because I am still a great believer that environment accounts for a very large percentage of the improvement for which the geneticists claim credit in the uplift of egg production." (Applause.)

Eunice E. Kidd said : " By his very comprehensive paper, Mr. King has made a most timely contribution to poultry literature. Such a clear condensation of the current theories of poultry breeding for production and health was badly needed and I am sure that both students and experienced breeders will be grateful to him for this survey given in such a palatable form.

" In so kindly including me in this discussion there can, of course, have been no illusions on anyone's part that I could contribute more than an onlooker's comments and views; and although my ' onlooking ' in the poultry industry may run to some years now, I do feel it a great honour to be invited to comment on a paper by such a well-known scientist as Mr. King and to follow a breeder so knowledgeable and experienced as Mr. Belfield.

" I am more than happy then, that Mr. Belfield should have dealt with all questions as to the soundness of breeding theories, the difficulties or ease of putting them into practice and also most of the economics of the game—whilst I confine myself to points in Mr. King's paper which stir me to comment in my capacity as an onlooker.

" Even so, the coverage of the subject by Mr. King and Mr. Belfield has left me feeling that if I were to add *my* little jingle—as Mr. Belfield has done—it would have to go like this:—

> Alas! my Child, it's all been said:
> And you will only bang your head
> Against a figurative wall,
> If *you* add anything at all!

" Nevertheless, I will try! The point I must deal with first—and with a deep conviction that it transcends all others in its present importance—is the current mortality rate in poultry flocks and particularly the problems of leucosis and lymphomatosis. With Mr. Belfield, I had hoped so much that in discussing this and other particularly costly diseases, Mr. King might have been able to do more than emphasise the state of affairs as we already know it. In speaking of ' Breeding for disease resistance,' Mr. King declares that ' although an inherited natural immunity to a prevalent disease such as leucosis would be of enormous importance, it is so essential that birds are profitable layers, that selection for egg yield must be the primary consideration.' Frankly, this statement worries me!

" To establish, by properly controlled breeding experiments, which birds carry a natural inherited immunity, is so difficult and so expensive, that extremely few breeders of foundation stock are able to practise it to an effective extent. At best, what is being done can only affect a very small proportion of the total foundation stock of the country. In such circumstances, therefore, leucosis will continue to spread to the commercial flocks on the farm—where its incidence is, if anything, even more serious, because as Mr. King points out ' it is not feasible to use this method (*i.e.* the selection of tested birds naturally immune to the disease) in commercial poultry breeding.'

" So what do we do? It seems to me, if we are still going to select primarily for egg yield, so long as we have these devastating diseases with us, matters cannot greatly improve. In fact, from my observations, there are already too many flocks in the country which have lost far more by leucosis or lymphomatosis in the rearing period and at point of lay on the numbers of young pullets originally housed—than they have gained by increasing the egg yield of the annually decreasing number of surviving birds!

" Personally, I cannot help but feel that we have now reached the point where we must put constitutional vigour and absolutely perfect health (so far as we can recognise it) before any records which deal only with production. Even so, how far this would help in dodging leucosis, lymphomatosis and other similar diseases, would of course depend on the standard of constitutional vigour and the details of its interpretation. And this is a subject in itself! To explain it would involve detailed descriptions of exactly what one would look for—from the way a bird moves, falls, wears its ' suit,' and crows or cackles—to the internal quality of the eggs laid—in addition to a thorough examination of its health log from a day old! I feel that having said that, in my view, far too little attention is paid to evidence of real constitutional vigour in many cases, I must, in view of the time factor on this discussion, leave it at that.

" But to give some point to my remarks, I wonder if Mr. King would kindly try and explain the following occurrence? At the Lancashire County Institute of Agriculture at Hutton, some Indian game cockerels were mated to Light Sussex hens, to produce table chicken. The average production of the Indian game's dams was 90 eggs—and that of the Light Sussex hens—130 eggs. The resulting pullets—over 100 of them—looked so good that it was thought a pity to send them for the table. They were therefore kept and recorded and they put up an average of 242 eggs per bird, with individual records up to 290 eggs.

" Could that great improvement in production be *entirely* due to heterosis? Or to nickability?

" In my view it makes one wonder whether a bird's laying potential *can* be fully realised with the present—or shall we say, the *usual*—standards of constitutional vigour. For, surely, it was mostly the superb constitutional

vigour—unimpaired by too much selection for records—which the Indian game birds brought to this mating? They certainly contributed nothing in the way of egg records!

"On the points Mr. King makes in breeding from hens rather than pullets, I would go with him all the way in his argument that both male and female birds should be given a chance to prove their liveability and their freedom from inherited disease or any predisposition to it, before being used for serious breeding. If only this were practised in all foundation stock it would soon have a marked effect on the country's commercial matings. Mr. Belfield is of course right that the modern male birds seem to age far too soon! But what a life they lead in many cases! Personally I think that environment has much to do with this, and I must say I agree with him so entirely on the subject of environment and management that, although I would still put constitutional vigour first in my selection of stock, I would never expect to get the full benefits of the best matings in the world if environment was not entirely favourable. But Mr. Belfield has asked Mr. King to describe standards of environments—and I hopefully look forward to his diagnosis of the subject.

"Mr. King has mentioned the importance of efficient food conversion—and I am sure this must receive greatly increased attention in the immediate future. The results of the first 500 Day Random Sample Commercial Test which we have just concluded at the National Laying Test at Milford, point most definitely in that direction. In the 40 pens of 50 day-old pullets (reduced at eight weeks to 25), there is a difference of £42 5s. 6d. in profitability, *i e.* food, against eggs laid plus sale of 25 young pullets plus carcase value of the 25 birds as yearlings.

"One pen (of Brown Leghorns x Light Sussex) laid an average of 187.48 eggs and earned £51 2s. 4¾d., yet another of the same cross averaged only four eggs less (possibly worth 34/6) yet earned only £38 3s. 4d. There was very little difference between any of the pens in what they earned for the 25 eight-week-old pullets, and so the difference between these two total amounts was mainly due to the conversion rates of food. I could give other equally striking examples of such differences and it makes one wonder how far such variations could affect the profitability of a farm carrying large numbers of birds from such strains. Certainly it is clear that breeding for an efficient food conversion rate must receive immediate attention by all breeders who intend to hold their trade. Hatcheries will also look for eggs from flocks which can show such efficient conversion. The highest food consumption per dozen eggs in this Test at the National was 9.08 lb. of food (2s. 10.30d. worth), while the lowest consumption produced one dozen eggs on 4.87 lb. of food—*i.e.* 1s. 6.27d. worth. No wonder hatcheries and egg producers alike are already asking eagerly for the publication of the food tables we have been preparing. Incidentally, I am told that hatcheries in Canada now give the potential food conversion rate with the chicks they offer! That is coming here, of course, and I would therefore like to have heard more from Mr. King about this factor and its influence on increased production from the flock.

"Mr. King has not said much about the effect on production of rearing methods. Distributors of stock—who know it to be good—are often made acutely aware how far various methods of rearing can affect later profits! The question is inevitably bound up with environment. Has Mr. King any observations to make on the most desirable environmental conditions during this critical period of life?

"Mr. Chairman, I am afraid I have been very unorthodox in many of my comments on a subject which has, in fact, been treated with great skill by those who know far more about its scientific aspects than I can ever know. May I be forgiven, I wonder, if I explain that it is only due to my delight that so eminent a body as the British Veterinary Association have drawn attention to the work which goes into the breeding of poultry in these days, by asking Mr. King to give his admirable paper—that I found the courage to come here at all!

"I know that the appreciation of Mr. King's paper by all those with whom I am associated in the Poultry Industry will be very real. Chick producers are always deeply conscious of such issues as Mr. King has raised, because the large scale orders which they have to handle naturally bring far-reaching responsibilities. It is therefore of particular importance to them that both breeders of foundation stock and of hatching eggs should have full knowledge of all factors recognised as essential in producing chicks which will give increased production with a clean bill of health throughout life.

"I do trust that if it has done nothing else, my rather unethical contribution has emphasised the poultry farmer's desire to co-operate with the veterinary profession in solving such problems as we have heard discussed to-day."

The General Discussion

Mr. T. Barton Mann (Weyhill) said that he had known Mr. King for many years as a very able veterinarian, especially in his own field of animal husbandry, but on this occasion it appeared that he had been given a subject to prepare a paper upon, which was beyond the capabilities of any veterinarian. The task had been handled admirably yet there were some very pertinent problems to solve. Mr. Belfield had mentioned a few in his excellent opening of the subject and he had every sympathy in his plea for more and more of better and still better advice from the profession.

Mr. Barton Mann thought he had some justification to enter a discussion on breeding if only in view of the fact that about 30 years ago he had succeeded in gaining awards at laying trials for both heavy and light breeds of poultry. However, the medals had been gained for the best performance of single birds, to-day the emphasis was on family performance and perhaps this was a change for the better. Mr. King had said that selection for disease resistance primarily could easily result in the production of a strain of poor, unprofitable layers. Because of this, it was his view that breeding should be left in the hands of the poultry breeders and that veterinarians should concentrate on disease for there were still a lot of problems to be faced. How far disease problems had been engendered by breeding was anyone's guess but how far they were engendered by environmental factors was the business of the veterinary profession.

He instanced research now proceeding at his own experimental plant where it seemed that docility was a matter of nutrition. Having fed to produce docility he was faced with psychology for while docile birds would eat out of his hand, or for that matter, out of the hands of anyone else, they would not eat a sufficient quantity of food from a trough placed in the centre of the house. They would eat more from a trough placed at the side of the house in semi-darkness but they would eat most by hand feeding. Food intake made a great difference to conversion ratio and profitability; his experience showed that protein content of the ration had nothing to do with appetite, the birds under experiment would eat a cereal pellet as greedily as pellets of 28 per cent. protein content. Once they had eaten pellets they could not be made to eat mash either wet or dry and they refused to eat small particles broken from pellets. For open troughs, on one diet the conversion ratio was 6 lb. of food per lb. gain in weight, for side troughs 4 : 1, for hand feeding, proportionately less depending on the patience of the hand feeder. A new field was being opened up as the result of these experiments.

Then there was the matter of coccidiosis. Did some strains of breeders produce progeny more susceptible than others? He thought that this was so for he had found that the progeny of certain strains of chickens and turkeys were more susceptible than others, all rearing being done under similar environmental conditions. It did not appear to be the degree of infestation for coccidia could be demonstrated in all.

Mr. Barton Mann had not heard of any investigations being carried out on paraffin brooding other than that proceeding at his own centre. His organisation used about 50,000 gallons of paraffin a year and the question of danger from this type of brooding was becoming more and more prominent. As far as the work had progressed it appeared

to have a bearing on the so-called "chilling" of chicks. It appeared to produce a poor blood picture and had a deleterious action on the precursors of blood cells in the marrow. It was very difficult to establish what constituted a "rogue" lamp. However, under the conditions of brooding on the farms under his control it had been found that a diet conducive to slow growth, which tended to keep the chicks too long near the source of heat also produced evidence of carbon monoxide in the blood, varying from 2 to 7 per cent., and an involvement of the haemopoietic system. A diet producing rapid growth, whereby the poults soon tended to leave the source of heat, almost eliminated these troubles. Check tests by electric brooding and the feeding of either diets showed that diet *per se* was not involved.

He wondered how far paraffin brooding throughout many generations had impressed lymphomatosis in poultry stock especially in view of present day apprehension regarding petrol fumes, diesel oil fumes, benzepyrene and carcinogens being implicated in the upsurge of lung cancer.

Dr. D. Luke (Belfast) said he would like to ask how far the author felt the present standard of egg size was compatible with really heavy production. Might they have to compromise in the matter of egg size in order to tie it up with body size and feed conversion.

Another point was that crossing two strains of pure breeds did not necessarily confer any added resistance to fowl paralysis. Experience of some crossings suggested the first cross was definitely much more susceptible to leucosis.

Dr. Luke wanted to support both the openers on the question of the ageing of male birds. They should make a plea for some competent authority to look into the matter of the early death of male birds. Certainly organic disease as such did not seem to be predominant, and the fact the birds were not living longer did reflect adversely on the value of progeny testing.

Mr. J. M. S. Lucas (Ongar) wondered whether the suggestion that leucosis was in any way connected with a hereditary factor—it was suggested by the word "breeding" rather than "rearing"—was not an assumption rather than an opinion based upon fact. The author had drawn attention to an experiment which connected the incidence of leucosis with higher egg production and the hatchability factor. They might well be wrong in assuming that there was a hereditary susceptibility to the disease, and they should look to increased production and stress factors rather than breeding. Regarding coccidiosis his experience did not confirm the contention that different systems of rearing, such as the one which included paraffin heating, had much to do with susceptibility. He dealt with a considerable number of experimental birds and there was no difference in their susceptibility. He did not think a hereditary factor was involved as the distribution of deaths was no different between the breeds.

Mr. Barton Mann wondered whether he had made his remarks clear about his suspicions of paraffin. The subject was a very difficult one for research. New analytical methods had had to be found for the estimation of small amounts of carbon monoxide in the small quantities of blood. A lamp might be a "rogue" for 24 hours when re-filling, trimming the wick and cleaning might stop its roguish propensities. There appeared to be no question that raw paraffin contained benzene-like substances if tests were applied. (Methods for the Detection of Toxic Gases in Industry. Leaflet No. 4. Benzene Vapour. Dep. Sci. and Ind. Res. London.) It had been possible to detect benzene-like substances in paraffin vapour from certain lamps. However, "benzene" and other organic solvents had been shown to be highly deleterious to humans. He referred to a reported case of delayed poisoning of a worker in a mackintosh factory who had used rubber dissolved in benzene as a solution for coating cloth and who, 15 years after leaving the factory, developed all the symptoms of benzene poisoning. The literature was filled with delayed action cases (*e.g.* BROWNING, E., Toxicity of Industrial Organic Solvents. 1952, *Med. Res. Council Rep. No.* 80. H.M.S.O., London.) He did not expect any immediate result from any investigation into paraffin poisoning for poisoning by organic solvents seemed to be a matter of degree depending on concentration of solvent and acclimatisation of the animal. Not all animals behaved alike; if experience of humans was criterion, some were resistant, others highly susceptible. He did not know whether a haemopoietic upset over many generations of chickens would impress itself on stock so that blood cells would adopt a new role and behave as they did in the leucoses. It certainly was a thought that one could not ignore in connexion with fowl paralysis.

To digress, he would assure Mr. Belfield that there was a greater interest being taken in poultry now than a few years ago. A new poultry section of the profession had been established. He thought that if Mr. King could not answer all the questions put to him the time was coming when an answer would be found for most of them. (Applause.)

Mr. J. E. Beach (London) said the paper stated it had been observed that there was a higher mortality rate among birds bred from pullets than among birds bred from hens. If there were some factor other than the fact that birds which for genetic reasons were unable to survive to their second year were likely to produce offspring of similarly low liveability, was there any valid reason for assuming that this factor would necessarily operate in the case of cockerels?

Mr. E. R. Callender (Lytham) wanted to pay a tribute to the author, who had been given a very difficult task which had been discharged in a very able manner, and to compliment the two openers.

The importance of environment could not, of course, be overestimated in estimating any sort of potentiality. There were the same sort of problems with the larger animals, but the remote chance that a herd of cattle might possibly become infected with foot-and-mouth disease in no way deters the owner from taking all possible steps to improve the breeding and management of that herd. It was pleasing to hear from Miss Kidd that far better use was made of game cocks in Lancashire than in Cheshire. (Applause.)

Mr. Whaley Taylor (Wolverhampton) said that he wanted to add a point about breeding from pullets or hens. Most of them seemed to be guessing but, if they were prepared to accept some American work according to a statistical method of measuring, in a closed flock the variation was 95 per cent. due to environment and 5 per cent. due to inheritance. Mathematically it was worth while to breed from the younger bird because more was gained than was lost by the possibility of inherited disease. If one wanted to be extremely careful one could of course identify the young birds, and by the end of four months' laying a good deal of information was available and the appropriate birds could be scrapped.

Dr. R. F. Montgomerie (Beckenham) said that he was not going into cock fighting or anything like that, but he was interested in the question of progeny testing, so much so that although it had been raised already he made no apology for adding the little he wanted to say. It seemed that the really important thing in progeny testing was for one to sit down in the beginning and decide what feature one was going to test for. If the purpose was to give the animal or bird the opportunity to give full expression to its genetic make-up as a producer one imagined it might have to be given almost ideal conditions in which to live during progeny testing; but if one was thinking in terms of possible disease inheritance then those were not the conditions under which to progeny test.

Those examples were rather extreme, but Dr. Montgomerie wanted to hear that there would be opportunities for going a little deeper into the point. In progeny testing the first thing was to decide what was being tested for and the second thing was to give the conditions which would allow the genetic features which existed in the blood in relation to that particular point to express themselves fully. That was something they should get quite clearly in their minds.

The Reply

Mr. King, in reply, said the first point raised by Mr. Belfield with which he wanted to deal was the selection of individual birds. Any person associated with poultry who had a knowledge of the species ought to have the ability

to select during the rearing period birds with stamina and the ability to live. There were the obvious signs of health and good physique which could be determined by handling and the birds could be culled according to the findings. It was much more difficult to select for productive abilty. Dr. A. L. Hagedoorn, the well-known Dutch geneticist, had told in a lecture how he invited a well-known English breeder to divide a flock of White Wyandotte pullets into three groups, those likely to lay well, those likely to lay poorly, and an intermediate group of birds that would be reasonably good producers. The English judge examined a large number of birds and carried out his examination carefully and divided them into the three groups. About a quarter went into the high producing group, about a quarter into the low producing group, and the remaining half went into the intermediate group. It was afterwards revealed that the whole exercise was carried out to test the theory of examination for production by handling and it was intended that all the birds should be kept. The birds were housed under similar conditions and at the end of the laying season it was found that the average egg production of the birds in the three groups was about the same. That pointed to the difficulty that was encountered, not only in poultry but also in other species, when judging for productive ability by external signs. It was difficult to select the best producers, but judging for stamina was possible.

When considering breeding systems where information was available about the history of families, it was possible by using the additional information available to make a much more accurate estimate of the value of an individual. In certain families various percentages died of disease, and the figures could be applied to selection.

The next question was that of environment affecting the testing of birds for production. They all knew that environmental factors influenced production. If one was setting out to test a family or line, and to compare it with others, the birds should be provided with the best environmental conditions that were possible. Particularly in testing birds of high productive ability was that essential. The environment should be so designed as to obtain the maximum possible out of each individual, and the information on management and feeding should be made available to purchasers so that they could obtain the maximum possible out of the birds with which they were supplied.

It was regretted that the diagram offended Mr. Belfield so deeply. Everybody carrying out experiments realised that they tended to go wrong and did not conform to diagrams, and it was included in the paper merely to try to show the principle behind the method.

There was the queston of the immunisation of birds against disease rather than the selection of birds for a resistance to disease. Mr. King considered that those working with poultry and interested in poultry would feel it was a retrograde step if it became necessary to vaccinate birds against varying diseases. The amount of work involved would be considerable and the cost of producing the vaccines would also be high. Surely that was one thing they wanted to try to avoid. It was better to produce birds that would live under the conditions that were available and not to have to vaccinate them against this, that and the other. That was a strong argument for the policy that was being carried out for the eradication of disease from farms and from the country.

Miss Kidd had given an intriguing example from Lancashire of the Indian game and Light Sussex crosses, and the interesting figure was the average yield of the Light Sussex birds themselves, only 130 eggs. There were two possibilities, of course. One was that the birds were bred from a strain selected purely for table purposes and the other was that they might have been a Light Sussex strain which normally would have been expected to lay, on the average, well over 200 eggs, but were handicapped in their production by some weakness or lack of stamina which was corrected by the Indian game cross. In the latter case the production of the superior crossbreds would be due to the stamina from the male and the hereditary high production factor from the female. The experiment was, of course, extremely interesting.

The question of leucosis had been brought out. They had to remember in discussing it from the aspect of poultry breeding that leucosis infection could be acquired by chicks through environmental factors, and that they were not dealing simply with a condition that could be controlled in the field purely by breeding. Some pullets would never be subjected to a heavy infection and therefore they would not show a heavy mortality. Others of the same or a different strain might have to stand up to much higher rates of infection.

The rate of food conversion was a subject which was becoming of increasing importance. It was one which had come into prominence fairly recently and most breeders in the past had had so many other factors on which to concentrate that they had not paid great attention to this subject.

Mr. Barton Mann's point on diet affecting docility was interesting and was probably new to most of them, and it was another factor that compounders of rations might have to consider in the future. Exactly what the factor was that would have to be included to bring about docility did not appear to be known.

Another interesting point was the susceptibility of birds from one farm to coccidiosis when compared with birds from another farm. If the birds happened to be of different breeding it might be an indication of an inherited susceptibility or resistance to the parasite.

Dr. Luke had referred to egg size. The point was that egg size and factors of quality were to a large extent determined by consumer demand, and the industry in its aim for higher production in order to satisfy the market had got to supply what the housewife demanded. When considering susceptibility to leucosis the environmental conditions under which crosses and pures were reared must be taken into consideration. Probably the crosses were reared on a greater variety of farms than pure birds and might be exposed to higher risks of infection.

The age of death of male birds was a question of importance to all who were concerned with progeny testing. Quite naturally, if any attempt was going to be made to progeny test a male, with the realisation of the large percentage of birds which would fail to attain the high standard that might be set, the birds that satisfied the requirements would be expected to breed for some years. Investigation into the cause of mortality in cocks might help such work.

As for testing males and females, Mr. King said that on the farms with which he had been associated and among the men to whom he spoke it was generally agreed that, with the labour and housing facilities available, it was far more feasible to try to progeny test the cock rather than the hen, although ideally of course they should both be tested. It was very interesting that Mr. Belfield considered that the testing of females was practicable.

The observation that paraffin might possibly induce or render birds more susceptible to leucosis was noteworthy, but it would be very difficult to obtain statistical evidence for this theory. Such views expressed by people from their observations were usually worthy of study, but they were not always confirmed by experiments because of other factors which were then controlled.

Mr. Beach had spoken on the question of breeding from pullets. Probably most breeders thought that by breeding from hens they at least bred from birds that had shown an ability to live. That was an old idea that had been put into practice in the poultry industry for many years and it was one that was subscribed to by most of the older poultry breeders.

If there were other points to be dealt with perhaps the openers would refer to them. (Applause.)

Miss Kidd, in reply, said she would like to comment on Mr. Barton Mann's reference to food conversion and the suggestion that it depended on psychology. Her reference to food conversion related to birds which were all fed in the same way. There should not have been any real difference in the psychology of the birds or of the approach of feeding.

There was then the point of environment referred to by Mr. King and by Dr. Montgomerie in connexion with progeny testing. Was the test being made for potential production under normal conditions or to find out how far the stress factors of modern egg production could be accepted? It seemed to her that if one was testing to find out how useful the bird was going to be as an egg producer and also as a potential breeder one must test under two different aspects of environment—under the full system of lighting and intensive feeding and also under normal conditions of breeding—to ascertain (a) what the bird would produce as a breeder, and (b) how far its constitution could stand up to modern conditions.

The experiment in which birds were segregated according to their expected production had interested Miss Kidd. Recently at the National Test a judge had marked birds for type, without knowing how they had produced. He chose them for type and his judgment proved absolutely correct according to production figures. He could, of course, be regarded as a very great stockman.

As regards the selection of male birds, when Miss Kidd was an assistant at a farm institute it was the practice when cocks for breeding were going to be selected to have the students well out of the way because the birds were chased round the run and only those that stood up to the ordeal and had a good steady heart action afterwards, according to a stethoscope, were deemed suitable! The method was very old-fashioned and primitive, but it seemed to work. Certainly some breeders still used a stethoscope when making their selection. (Applause).

Mr. Belfield (in reply), said he was sorry to have hit out at the author's diagram. Perhaps the real reason was that the paper read so well it made the whole subject sound too easy. As for the things Mr. King wrote about, there was a headache in every sentence. The disease problem was far too complicated for Mr. Belfield, who looked upon disease as being any departure from the normal, and whatever name was given to a disease—and veterinarians were pretty good at giving names—it did not frighten him. His selections were made upon the basis that any ill health or disease was a departure from the normal. That, however, still did not clear up the type of environment to be used in selecting birds. Probably everyone agreed that if 10 birds were being tested against another 10 birds they must all have a similar environment, but he was not sure what plane the environment should be on. If one tested birds on the highest possible plane then one must assume that one's customers were using that plane—and if they were not, there was a very tricky problem. A breeder could achieve terrific records—95 per cent. liveability—but the customers would not reach it.

The latest method of test used in America, which the National Laying Test had followed, was the random sample test, and all the birds coming in at a day old were subjected to a standard infection of leucosis. It could be said that that hardly showed a high standard of hygiene, but it seemed to be a much more fruitful way of operating than that of always having tests on a very high plane.

One further point on food conversion was to recall the examination question "What can you do to breed for better food conversion?" Those who got the correct answer said "Nothing," and that appeared to be right. There was a lot of hooey being talked on the subject. Food conversion to Mr. Belfield's mind was related to body size, speed of laying and rate of maturity, and those were the economic factors.

On progeny testing of males, one method was to find one really super male, and he thought he was in line with Mr. Henry Wallace in America in saying the ratio of that type of male was one in 500. (Applause.)

The Chairman said that 20 years ago the poultry industry of this country was in a sad plight. A Poultry Technical Committee was set up to inquire into the reasons, and one of the sentences of the Committee's report he had never forgotten. It said, "A blight has descended on the poultry industry of this country." Literally thousands of poultry owners were going out of business—and the blight was largely leucosis.

They must all be concerned about the mortality figure of 20 per cent. which was again with them. One bird in five was dying before its first year of production was finished. Were they going back towards "the blight" the Poultry Technical Committee mentioned 20 years ago? If such mortality were applicable to cows what would they think? They must surely finish the meeting feeling that it was their job as a profession to make the birds live.

They had heard during the session repeated mention of such terms as "constitutional vigour," "liveability," and so on. It would be agreed that the writer of the paper and the openers of the discussion had all displayed excellent "constitutional vigour," in dealing with their respective tasks. They were very gratified indeed to have had with them Mr. King, who had tackled a $64,000 question in a marvellous manner, and they must all feel like adopting Wilfred Pickles' words "Give him the money!" (Applause.)

Miss Kidd had travelled all the way from London to attend the meeting at considerable inconvenience. Miss Kidd maintained she was an onlooker, but they would not believe a word of that; she was the most experienced lady on the subject that one could possibly listen to. (Applause.)

Mr. Belfield had come from Salisbury to give them the benefit of his advice, and once again they were very grateful indeed to have somebody so well known in the breeding world to address them. Having had personal contact with Mr. Belfield over a number of years, and having seen some of his efforts in family selection, the Chairman could say that the number of birds and the number of complete families he had scrapped because of some slight fault were really staggering.

The meeting would join in thanking very heartily those three people who had attended the Congress and made such excellent contributions. (Applause.)